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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 30.

Institute of Metals (Birmingham Section):—Annual dinner at Birmingham.

Institute of British Foundrymen.

NOVEMBER 29.

London Branch (Junior Section):—Ordinary meeting in London. "Some Elementary Notes on Brass and Bronze." Paper by H. C. Dews.

NOVEMBER 30.

Wales and Monmouth Branch:—Ordinary meeting at Bristol. "Continuous Casting Methods," Lecture by A. S. Beech.

DECEMBER 6.

London Section:—Annual dinner in London.

International Interchange.

Reference has previously been made in these columns to the series of Papers exchanged annually by the leading foundrymen's associations of the world. Further, suggestions have been put forward as to the best use and the wisest development of this most valuable medium of international interchange. Any such international activity, however, involves certain problems that are inherent in its very nature. Notably, there is the problem of language. It is only a minority in the foundrymen's associations of the leading countries that possesses a fluent knowledge of the language of the others, still less any knowledge at all of the languages of the lesser and less accessible countries. To some extent this is a problem that is bound to grow with the growth of internationalism, whether specialised or general, with the resulting inclusion of more and more countries in the exchange Paper scheme. On the other hand, it is worth noting that these rather less accessible or hitherto less influential countries, such as Poland or Czecho-Slovakia, are keenly alive to the restrictions that their language imposes on international contact, so that early and thorough acquaintance with French, German, or English is usually a matter of course with them. Broadly speaking, therefore, the language problem of the exchange Paper may be confined to these three tongues. The usual practice is, of course, for the author of an exchange Paper to prepare it in his own language and send it to the receiving association for translation. It is not always appreciated that mere word-for-word translation is a comparatively small part of the problem. A sound knowledge of the subject is required if technical words and phrases are to carry their full meaning, and the entire system of units employed has to be transposed—in the case most nearly concerning us—from the metric to the English system. While admitting that this is not an easy task, we would suggest that no one is better fitted to see that it is efficiently carried out than the receiving technical association concerned. From time to time attempts have been made by the authors of exchange Papers to write these Papers direct in the language of the receiving country. Experience has proved this to be unsatisfactory, since complete bi-lingualism is extremely rare—so rare that it attracts a good deal of attention when it arises. In the absence of such bi-lingualism, the author must either write his Paper in a language with which he is imperfectly acquainted, or he must himself translate it when it is written. In the first case, it is obvious that a man can best explain his work and develop his theories in the language that is native to him. Anyone who considers himself a good linguist has only to try his hand at writing a technical Paper in French or German to appreciate this fact. In the second case, if the Paper has once to be translated, why not have the translation carried out in the receiving country with the supervision and co-operation of the receiving organisation? It seems pertinent to add that while language teaching in this country leaves a great deal to be desired, its improvement would not solve this particular problem. Such exchange Papers will continue to need translation unless or until something in the nature of complete tri-lingualism is effected. In the absence of this somewhat remote possibility, it seems important to secure that the translation is done under the best possible conditions.

Mechanisation for Modest Foundries.

The Birmingham Branch of the Institute of British Foundrymen at their last meeting received some good advice from their lecturer for the evening, Mr. R. Spriggs, of Loughborough, when he advised founders to experiment with a length of gravity conveyor as a nucleus for mechanisation and human-effort economy. We know of a case where one moulder is walking over five miles a day carrying his boxes and returning to his machine. Again, we remember a statement by a foundry manager that a certain moulding machine was only working 5 per cent. of its time. This was not the fault of the machine, but merely the inability of the staff adequately to handle its production. Time will undoubtedly see the creation of more foundries of the Morris type, but for the majority of foundries, ability to cope with a change in type of output must be regarded as an essential. Thus elasticity must be the key-note in any mechanisation scheme, and it is here where a start can and should be made with simple gravity conveyors.

Mr. Spriggs also has postulated a minimum daily usage of 10 tons of sand to warrant its mechanical handling, but, rightly pointed out, that where a grab-bucket can be made to interchange with a magnet, the field of mechanical handling can be extended.

Another point stressed by Mr. Spriggs was that one can replace a modern well-constructed cupola stage by a mechanical charging device at but little or no extra capital cost. Contrary to general opinion, we believe a better control can be had from the ground floor than from an elevated staging. By control, is meant both "stocks" and final composition.

We are of opinion that the necessity for conveyor systems is being impressed upon foundry executives more and more every time a moulding machine is installed. Too often is moulding time saved at the expense of core-shop costs, and saved ramming energy dissipated in walking. For the modest founder, we suggest that his first objective should be the getting of the work away from the machine. This accomplished, the necessity for the bringing up of the sand and boxes mechanically to the machine will soon impress itself upon the management.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Fracture and Composition of Pig-Iron.

To the Editor of The Foundry Trade Journal.

Sir,—As one of the earliest advocates of the value of fracture to the ironfounder, it was of great interest to read the report of the Paper given by Mr. J. G. Pearce at Middlesbrough, reported in your current issue, page 367.

The chill test is certainly one of the best rough-and-ready tests for an ironfounder, but he requires to know how to read it correctly, and this is only done by long experience.

It was to be expected that sooner or later Mr. Pearce would realise the value of fracture. In the term "cast iron," pig-iron must also be included, because the value of fracture in the pig-iron is inherent in the castings in which it is used. That is now quite commonly accepted, although there is still a minority, perhaps, who disagree—that, however, is their misfortune.

The fracture of pig-iron gives the ironmaster valuable information which is of no direct interest to the ironfounder, whilst fracture also gives the ironfounder valuable information which is of no direct interest to the ironmaster, but the true value of fracture is not fully understood without the complete information.

Anyone having this complete information would be satisfied to use pig-iron by fracture only, but it is much safer and easier for the ordinary ironfounder to know the fracture and then work to analysis, which is becoming common practice to-day.

Mr. Pearce states: "Unfortunately the engineer, chemist and metallurgist could not read fracture." Now, if Mr. Pearce would qualify this and say "some," he would have my support, and, in view of his statement, he may be surprised to learn that twenty years ago at one of the Tees-side furnaces, not now operating but where pig-iron was largely graded by analysis, there was employed an ordinary workman who could give the silicon contents of every cast of the furnace within 0.25 per cent. of the actual laboratory results.

Perhaps Mr. Pearce would like answers to some of his questions in paragraph 6, column 1, of your report.

1. The fracture of pig-iron is controlled primarily by the size; and next, by the percentage of graphite.

2. It is not possible to have a very strong open iron, but it is possible to have an open iron as strong as one closer.

3. It is possible to have a very close iron which is weak.

4. Generally speaking, if two furnaces are working at equal temperatures, one on hematite and the other on high phosphorus (*i.e.*, foundry) iron, the latter will be the closer fracture.

5. Exactly the same percentage of C.C. can be present, both in an open and very close pig-iron, and C.C., of course, represents the percentage of carbide present. This statement will no doubt answer Mr. Pearce's query.

6. Mr. Pearce asks: "Could an experienced man take size fully into account?" And if he refers to grain size and size of graphite, the reply to his question is that an experienced man, having a *complete* knowledge of the cause of variations in fractures and the effect of these variations on re-melting, such a man can visualise "size" effect in a casting.

7. The colour of the fracture, whether grey, mottled or white, also has its meaning.

Towards the end of the last paragraph but one of your report, Mr. Pearce states "we could estimate analysis from microstructure." Experience shows that this is not possible. Just twenty-one years ago, when living on Tees-side and coming into frequent business touch with the late Dr. J. E. Stead, thinking to help the ironfounders to work easily on scientific lines, he thought of advocating the use of the microscope in the foundry instead of a laboratory. In discussing the possibilities of this with me, it was proved to him that no complete analysis could be even estimated from the microstructure and the matter was wisely dropped.

What the microscope can disclose is:—

1. Whether the graphite is large or small.

2. The approximate percentage of G.C., C.C. (carbide), sulphur and phosphorus, but that is all. It gives no indication of the percentage of silicon and manganese.

On the other hand, the reading of the fracture itself by the eye can give what the microscope can disclose, and in addition it gives a rough idea of the phosphorus and manganese contents, the latter largely by colour, but there are also other indications.—Yours, etc.,

E. Adamson.

18, York Street,
Sheffield.
November 25, 1929.

P.-M.-G. Metal.

To the Editor of The Foundry Trade Journal.

Sir,—I must protest against your onslaught upon Admiralty gun-metal in the unsigned article on P.-M.-G. metal which appeared in your issue dated November 21. Describing the evolution of this alloy, you say that "in common with the majority of foundrymen, the staff had no particular love for Admiralty gun-metal, with its poor casting properties," etc., and later, "the resultant alloy (P.-M.-G.) is superior in every way," and so on.

I do not wish to pass any comment on the merits or drawbacks of the copper-silicon alloys with the addition of manganese, iron and so on, except to suggest to you that no scientific comparison can be made between these or any other new alloys and our more popular materials unless the real facts about the older materials are correctly set forth.

Admiralty gun-metal has been successfully cast into thousands of tons of intricate and highly-stressed castings to the rigid inspection of the British Admiralty and leading engineering authorities for the past thirty or forty years, and it is still being cast successfully. What, unfortunately, examples lead you, then, to the impression that it had poor casting properties? Many who are successfully casting this alloy will agree with me also, I think, and the back numbers of The Foundry Trade Journal, testify that the Admiralty gun-metal test figures you have given are by no means fair to Admiralty gun-metal.

One assumes that, by inference, you also indict gun-metals other than that known as 88-10-2, and if this is the case I would suggest again that a closer attention to the facts would have made the comparison fairer on "economic and practical grounds."

Your readers would doubtless have been further interested in your comparisons if you had included the number of the patent of which you state this new alloy forms subject.—Yours, etc.,

H. C. Dews, Metallurgist,
Dewrance & Company.

165, Great Dover Street,
London, S.E.1.

[We can assure our correspondent that comparison was confined to 88-10-2 A.G.M. on account of the expensive 10 per cent. tin content. We also would refer Mr. Dews to the discussions which have taken place before the various Branches of the Institute of British Foundrymen, which by the length alone certainly conveys the impression of rigid control to achieve perfection. The authority for the average Admiralty gun-metal properties is Dr. Hanson, Feeny Professor of Metallurgy at the University of Birmingham.—Editor.]

Random Shots.

A problem that is always present to thoughtful men in the foundry industry is the difficulty—if not the impossibility—of obtaining any reliable statistics as to its output, etc. This is clearly the result of the nature of the trade. It is comparatively easy to obtain statistics, say, of flour-milling or of cotton-spinning, since either of these is a clearly-defined trade in itself, not closely associated with other industries—certainly not closely associated with a large number of other trades—and so capable of disentanglement. Founding, however, is nothing of the sort. It is a process basic to the greater number of our industries, including all our heavy industries and practically all our mechanical industries. It is carried on partly in specialised and jobbing foundries, partly in foundries attached to engineering and automobile works, and partly, again, in connection with blast furnaces and steelworks.

* * *

Nor is this situation likely to improve. Every year sees more and more combination—rationalisation is still the fashionable term for it—and the more horizontal combination there is the more vertical combination there is likely to be as well. A single small motor works cannot run its own foundry, but must buy its castings outside; half a dozen motor works amalgamated into one great concern can and will run their own foundry. Our biggest soap combine, I believe, owns its own palm groves in Africa and indulges in other picturesque manifestations of vertical combination; so we may perhaps look forward to a time when it will be harder than ever to disentangle statistics of the foundry trade.

* * *

As an example, I remember that Mr. Martin, delivering the Autumn Lecture of the Institute of Metals at Liverpool a year or so since, gave some figures relating to the composition of marine engines. His purpose was to show the importance of non-ferrous metals in this connection, but, to my mind, he rather showed—or at least his figures alone showed—the importance of cast iron. He gave the percentage of cast iron as 70.75 in the case of a steam reciprocating engine, 58.0 in the case of a turbine of the same power, and 41.1 in the case of a Diesel engine. . . . Then, again, I saw recently that this country's cast products could be given an approximate minimum annual value of £40,000,000. The point is that these figures are interesting and significant, but they don't take us far enough, and even they have to be "dug out," as it were, with considerable difficulty. When will the Board of Trade give us what we want?

* * *

Did you ever hear the story of the somewhat dilapidated lady who walked into a London house of refreshment and demanded "a li'l drop o' gin for me lidy friend outside." For some reason the proprietor's suspicion was aroused, and he inquired cautiously why the lady friend didn't come in and make her own purchase. The lady looked at him in disgust. "Well," she said, "if you wants ter know the reason, she can't come in becos she's a-lyin' darn!"

* * *

When some of our daily newspapers talk about circulation figures, they seem to suffer from ecstatistics. . . .

Marksman.

Making Iron from Primitive Times.*

By Professor A. A. Read, D.Met., F.I.C.

Archæologists seemed generally to have arrived at the conclusion that the age of iron followed the age of bronze, mainly from the fact that, whilst ancient objects of iron were exceedingly rare, ancient objects of bronze were abundant, suggesting that metallurgy of bronze was highly developed before iron came into use. It is, at any rate, certain that before iron came into use the metallurgy of bronze was already highly developed, and also the art of bronze founding; the making of cored castings was undoubtedly known. In many of the tombs discovered, bronze objects were found, as also were bronze rings with a little iron let in, showing the iron was considered the rarer metal of the two. It should be remembered that iron is rapidly corroded by oxidisation, even in dry climates, whereas bronze was very slowly acted upon even in moist climates.

In Egypt many wonderful works in stone were to be found in the temples, pyramids, sculptured walls, tombs, etc., many of them prepared from the intensely hard Assouan granite, porphyry, etc., with figures and hieroglyphics sometimes cut to a depth of no less than 2 in. Chisels and wedges of bronze would be of little use for shaping and cutting these huge hard stones, and it is far more probable that the Ancient Egyptians had steel for tools of all kinds, obtaining the necessary material and help from workmen of other nations, India and China. At the recent meeting of the British Association for the Advancement of Science, held in South Africa, Dr. Frobenius, the German scientist, put forward proofs that the iron industry had flourished in the interior of Africa earlier than 3500 B.C., or 2,500 years before the use of iron was known in Europe. A most important discovery had been made, he said, of bronze developed in Central Africa at a later period.

No doubt the discovery of iron was made at a very early age, as the production of small masses of malleable iron is one of the simplest of all metallurgical operations, requiring only a small furnace without blowing apparatus, such as can be made by digging a hole in the side of any bank exposed to the prevailing wind, a supply of easily-reducible ore and charcoal for fuel. The temperature at which iron can be reduced from ore is something under 500 deg. C., and the iron would be produced in a pasty condition. It is generally held that iron was first produced in workable quantity on the southern flank of the Caucasus, and the date assigned is usually somewhere about 3000 B.C.

Mention of iron is found in the Book of Genesis, where Tubal Cain, sixth in descent from Adam, is referred to as an instructor of every artificer in brass and iron. Iron has been known and prized from the very earliest historical period, articles of the metal having been found amongst the contents of the Great Pyramid of Egypt. One of these, a thin flat irregular wedge, 9 in. long and 3 in. broad, is to be seen in the British Museum. It is believed to date from 3733 B.C. This is older than the earliest bronze. There is also in the British Museum an iron axehead which is dated about 1370 B.C.

Plans were shown of three iron furnaces found by Sir Flinders Petrie at Gerar—sometimes known as Gemmeh—a district about eight miles south of Gaza, on the direct road from Egypt up to Jerusalem. Two of the furnaces, one intermediate between the XXth and XXIInd dynasties and one of the XXIInd dynasty. The earliest is the largest and best preserved. All three furnaces have recesses at the side, sloping wider upward to allow of a draft without being so much encumbered with the charge. The openings all faced west to catch the prevailing wind. Probably the top was arched over between the recesses to retain the heat. The oldest furnace is almost as old as any dated iron known in the Mediterranean, excepting some knives found at Gerar of about 1300 B.C. It proves that smelting was done on the spot and that the metal was not imported for manufacture into knives, swords, picks, etc. A slide was also shown of the remains of a sword furnace found at Gerar which was a cubical firebox from which extended a trough which shows evidences of having been heated to fluxing point. This trough is 3 ft. long, and can be covered with pottery slabs, which were removed to take out the sword blade.

Referring to Assyria, iron was used in Nineveh in considerable quantities, and excavations made by Col. Layard resulted in the discovery of picks, hammers and saws made of iron, and believed to be of a date not later than 880 B.C. These can be seen in the British Museum, and it would be seen that the form of the implements made in those days differed very little from those made at the present time.

Aristotle, 384 to 322 B.C., describes the process of making steel used in India, which is still produced under the name of wootz. The famous Iron Pillar at Kutub, near Delhi, was shown on the screen. This stands 22 ft. above the ground, and its weight is estimated to exceed 6 tons. It was probably made about A.D. 400 by welding together discs of metal. So great a forging at this period indicates a remarkable skill amongst the early iron workers of India.

British Developments.

The Ancient Britons were acquainted with the use, and also probably with the production, of iron some centuries before the Roman invasion under Julius Cæsar, 55 B.C., for at that time they had swords, spears, scythes and hooks of iron. Cæsar mentions that the currency of the Britons consisted partly of iron rings. When the Romans invaded this country they set up forges in different parts of the country, and at Ely, near Cardiff, can be seen the remains of one of these forges. Discoveries in Ireland point to iron having been made there in the year 50 B.C., and the illustrations showed implements not unlike the spears in use by savages of the present day. Also horse-shoes, nails, implements, etc., found at Ely Racecourse, Cardiff, differed very little from present-day shapes, etc. These are to be seen in the Welsh National Museum. An illustration of a sickle and spearhead found near Treherbert, Glam, was assigned to the year 400 B.C., and there were also slides of specimens from Scotland, A.D. 50, and Caerwent, A.D. 400. Pliny (A.D. 23-79) describes the making of iron and steel, especially remarking that the quality of the latter depended upon the quality of the water used for quenching and that small tools were tempered in oil.

Professor Read then suggested going back again and looking at some of the furnaces and appliances which were used in prehistoric times, and the following slides were shown:—

(1) This was the first known picture of blowing up a fire, and showed this being done by bamboo canes tipped with clay. It was taken from a fresco by Beni Hassan and was said to date from about 2500 B.C.; (2) the earliest known form of bellows in Egypt, and was taken from the walls of a tomb of the period of Thothmes III about 1500 B.C. An identical type of bellows is still used in India by certain tribes, the only improvement being the use of two light bamboos which act as springs to pull up the skin cover; (3) an iron furnace in the Khasia Mountains in India which illustrated the use of another primitive form of bellows; (4) a furnace in the Salem district, 4 ft. 6 in. high, 3 ft. 6 in. dia. at the base, and 1 ft. 10 in. dia. at top. The blast was introduced from a goat-skin bellows by tuyeres which were merely hollow bamboos tipped with clay; (5) a Sierra Leone furnace with pear-shaped body 6 ft. high, 5½ ft. dia. at ground level, with walls 9 in. thick made of clay. This had eight air-channels made of clay pipe of 1 in. internal dia. Such primitive furnaces are still in use; and (6) an Osmund blast furnace, made of refractory stone, the space between this lining and the timber casing being filled with earth. An oblong rectangular cavity received the lump of reduced iron, which was afterwards extracted near the tap-hole. The output was not more than 1½ tons of iron per week. In all these illustrations it was shown that the side of the furnace had to be taken away to get the metal out.

Agricola, the historian, in his work dated 1556, describes in much detail the construction of bellows with valves, worked by water-wheels, and it is obvious from his description that the appliance was old enough for its details to be standardised. The German stückofen, dated A.D. 1400, was built in the shape of two cones. The front of the hearth was made with a thin wall which was taken down at the end of the operation to remove the iron. German metallurgists, in their endeavour to save fuel and reduce cost of manufacture, introduced blast furnaces of gradually increasing size, and by allowing the metal to remain in contact with the fuel became carbonised and was obtained in the fluid condition.

Birth of Cast Iron.

About the year 1500, metallurgists had a new metal which could be cast into any desired shape or form, and it was then that cast iron came into being. In 1716, methods were improved and we find the blauofen, which differed but very little from those furnaces of a century earlier. These were small blast furnaces about 30 ft. high, and produced from 7 to 10 tons of metal per week using charcoal as a fuel. The resulting pig-iron was afterwards converted into wrought iron in a finery or small hearth not unlike a smith's fire.

The large quantities of wood employed for the production of charcoal led to the introduction of various Acts of Parliament during the reign of Elizabeth (1558-84) restricting the number of ironworks and prohibiting the erection of new works in certain districts. This great scarcity of charcoal directed attention to the use of pit coal as a substitute. In 1620, Dudley succeeded in preparing coke from Staffordshire coal, and by using this coke produced pig-iron in the blast furnace. He met with opposition from other ironmasters, and the bellows of his new furnace were cut to pieces by riotous persons, causing the manufacture to be abandoned, and it was not until 1730, when Abraham Darby introduced coke at Coalbrooke Dale, that the use of coke in blast furnaces became general. In these days blast furnaces were always in the neighbourhood of forests and water, so that the trees might produce the charcoal, and the water the power for working machinery.

In 1720, furnaces were found to exist as under:—Brecon, 2; Glamorgan, 2; Carmarthen, 1; Cheshire, 3; Denbigh, 2; Derby, 4; Gloucester, 6; Hereford, 3; Hampshire, 1; Kent, 4; Nottingham, 12; Salop, 6; Staffordshire, 2; Worcester, 2; Sussex, 10; Warwick, 2, and Yorkshire, 6, and the average output was not quite 300 tons per furnace per annum. It will be seen Kent and Sussex were large centres, and it may be that the iron industry will return there with the opening of the Kent coalfields. The iron bridge at Coalbrooke Dale, Salop, dated 1779, had five arches and a span of 100 ft., but it would be of little use for the traffic of the present day!

A Welsh blast furnace built about 1825, with a solid masonry wall and a cubical hearth, had

* A Paper read before the Wales and Monmouth Branch of the Institute of British Foundrymen, Mr. W. S. Kinsman presiding.

an open top where the exit gases would burn, and would yield about 25 tons of pig-iron per week, requiring about 3½ tons of raw coal per ton of pig. Blowing-engines had now been introduced due to the discovery of steam by Watts. The year 1829 saw the introduction of hot blast by Neilson. This was a pistol-pipe stove heated by blast-furnace gas, the gases being drawn off by means of chimney draft through openings below the level of the materials in the surface.

Furnaces with square hearths took some months to arrive at their maximum production, and by this time sides had been so much melted away that the hearth had become round, its diameter much increased, and the boshes worn away so as to be much steeper than built originally. Gibbons' idea was to build his furnace as nearly as possible to the internal shape which furnaces that were known to have worked well had formed for themselves in actual practice, and about 1835 the hearths were made circular and bigger, with steeper boshes, wider throat, more tuyeres and hot blast, which led to increased output. Such furnaces were between 45 and 60 ft. high.

In 1854, Parry introduced the "cup and cone" furnace at Ebbw Vale. This was easier to take off the gases, but it took many years for this method to be adopted. In 1854 the Staffordshire furnaces had not adopted the cup and cone method, but still had an open top with a very small hearth. The year 1860 saw the recuperative system invented by Siemens applied to heating the blast with waste gases by Cowper. Attention was drawn to the manner in which the heating of the blast had reduced the coke consumption per ton of pig-iron produced, and illustrations were shown which emphasised the rapid development which has taken place within the last decade or so in the design and construction of the present-day blast-furnace plant.

Vote of Thanks.

In calling upon Mr. Richardson to propose a vote of thanks, Mr. Kinsman expressed his gratitude to Prof. Read for a most instructive and interesting talk.

Mr. R. J. Richardson said he had listened to the talk with interest, and it had been made more useful since it followed the visit to the Dowlais Works. With a lecture such as the meeting had just listened to, the Branch had a fine ending to an extremely interesting day. It was very instructive to learn what had been done years ago. He had the utmost pleasure in proposing a hearty vote of thanks to the Professor.

Mr. Southgate, in seconding, said the lecture would naturally go down much better after such a visit as had been paid in the afternoon. His guide at the Dowlais Works, Cardiff, had told him that in the future they intended running the iron into chilled pigs. He wondered if Prof. Read could tell them what effect this would have.

Prof. Read said that one would not be able to judge the fracture of these pigs compared with the fracture of those cast in sand because the pigs would cool very much more quickly, and the quicker cooling would not allow the crystals of graphite to form as well as if it had cooled in the sandbed. The iron so cast would be closer, denser, and the crystal graphite would be smaller. He did not think the melting properties of the iron would be adversely affected.

International Combustion, Limited, Africa House, Kingsway, London, W.C.2, announce that their associated company, International Combustion Engineering Corporation, of America, have secured from the Ford Company an order for two double Ladd boilers, 700,000 lbs. each actual maximum evaporation, 1,400 lbs. pressure, 750 deg. Fah. superheat, and also a further order for two boilers, of 300,000 lbs. maximum evaporation at 1,400 lbs. pressure and 750 deg. Fah. superheat, for Milwaukee.

I.B.F. Branch Presidents—No. 2.

SHEFFIELD BRANCH.

Mr. George L. Oxley was born in 1896, and was educated at the Wesley College, now the King Edward VII School, Sheffield, and at Ackworth School, near Pontefract.

He entered the foundry of Messrs. Davy Bros., Limited, Park Iron Works, Sheffield, as an apprentice-moulder, and also spent some time at the Applied Science Department of the Sheffield University.

After six years at Messrs. Davy Bros., Mr. Oxley joined the Army during the Great War, and then joined the firm of Messrs. George Oxley & Sons, Limited, Vulcan Foundry, Attercliffe Road, Sheffield, now holding the position of secretary. He has been a member of the Sheffield Branch of the Institute of British Foundrymen since 1915.

Mr. George L. Oxley.

Institute of Metals—Sectional Chairmen.

No. 2.—NORTH-EAST COAST SECTION.

Mr. Samuel G. Homfray, B.A., son of the late Mr. S. G. Homfray, J.P., M.I.C.E., was born in London in 1888. He was educated at Cheltenham College and at King's College, Cambridge, and gained Second-class Honours in the Mechanical Sciences Tripos in 1909.

Mr. Homfray served a short apprenticeship in the Engine Works Department of the Elswick Works of Sir W. G. Armstrong, Whitworth & Company, Limited, and was appointed an assistant manager in that department in 1911. He became manager of the Brass Department in 1925, and was transferred last year in the same capacity to Messrs. Vickers-Armstrongs, Limited.

Mr. S. G. Homfray.

Contracts Open.

Cairo, February 1.—Pumping machinery, for the Egyptian Ministry of the Interior. The Department of Overseas Trade. (Reference A.X. 8,811.)

Cape Town, December 4.—50 tubular poles, 35 ft., 1,500 tubular poles, 30 ft., and 200 cast-iron pole bases, for the City of Cape Town Electricity Department. The Department of Overseas Trade. (Reference A.X. 8,773.)

Christchurch, N.Z., December 13.—Four automatically-controlled pumping plants, etc., for the Christchurch Drainage Board. The Department of Overseas Trade. (Reference A.X. 8,788.)

Dublin, December 4.—Iron and steel stores, for the Commissioners of Irish Lights. The Secretary, Irish Lights Office, Dublin.

Hemel Hempstead, November 27.—Two high-lift turbine pumps, etc., for the Town Council. Mr. A. Murray-Smith, water engineer, Market Square, Hemel Hempstead, Herts.

Southampton, December 12.—10,200 yds. of 15-in. c.i. socket and spigot pipes and 30 tons of special castings, for the Corporation. Waterworks Offices, 21, Shirley Road, Southampton.

Stoke-on-Trent, December 10.—3,550 tons of cast-iron pipes, 16 to 24 in. dia., for the Staffordshire Potteries Water Board. Mr. R. C. Frain, engineer and general manager, Staffordshire Potteries Water Board, Albion Street, Hanley, Stoke-on-Trent. (Fee £5, returnable.)

Reports and Dividends.

British Thomson-Houston Company, Limited.—Half-year's dividend on the 7 per cent. cumulative preference shares.

Dorman, Long & Company, Limited.—Dividend on the 6 per cent. preference shares for the half-year ended September 30.

Indian Iron & Steel Company, Limited.—Net profit, Rs. 57,22,076; brought in, Rs. 1,23,986; interest on income debenture held by Bengal Iron Company, Limited, Rs. 30,24,263; final dividend of Rs. 1.2 per share, making Rs. 1.8 per share; written off discount on debenture issue, Rs. 1,00,000; to reserve, Rs. 4,00,000; carried forward, Rs. 1,34,959.

Company News.

A. & W. H. Bury (Darwen), Limited, Hanover Foundry, Extreme Street, Darwen.—Capital £2,000. Engineers, etc. Directors: A. Bury, W. H. Bury and C. Cash.

An offer has been made by Associated Lead Manufacturers, Limited, to acquire the entire share capital of Messrs. Walkers, Parker & Company, Limited. The company already controls about 40 per cent. of the £278,750 issued capital of the latter concern.

The Founding of Some High Melting-Point Non-Ferrous Alloys.*

By J. McNeil, A.R.C.T. (Glasgow).

Modern engineering requirements make it essential for the designer to devote the greatest care to the choice of materials to be used, and in many cases results in the demand for castings to meet certain rigid specifications. To meet these demands the metallurgist is called on to evolve suitable alloys. This done, then it falls to the foundryman to make castings as required in these particular materials, and not only that, but to produce them at a cost which does not allow of much margin in the foundry.

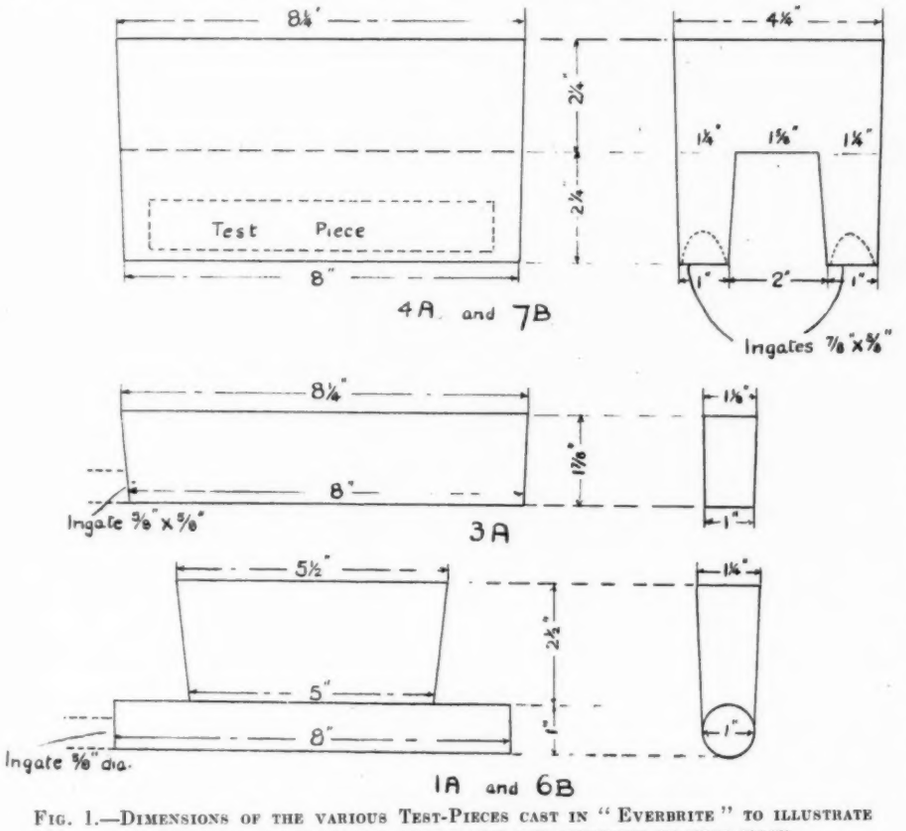

FIG. 1.—DIMENSIONS OF THE VARIOUS TEST-PIECES CAST IN "EVERBRITE" TO ILLUSTRATE THE EFFECT OF THE CARBON PICK-UP ON THE STRENGTH OF THAT ALLOY.

To do this it is necessary that those responsible, both for the melting of the metal and for the preparation of the moulds, should be thoroughly conversant with the nature of the materials which they are called upon to employ.

Of the various non-ferrous alloys commercially available which the designer can adopt to meet high stresses, corrosive or high-temperature conditions, those in which nickel forms the basis possibly cover the widest range, and as it is very probable that members of the Institute of British Foundrymen have from time to time to produce castings in these materials, it was considered that it would be well worth while going over a few of the more salient features connected with their production.

The fact that nickel is present in considerable percentages brings such alloys under the class of high melting-point materials. Pure nickel, according to the latest determinations carried out by the Washington Bureau of Standards, melts at 1,454.9 deg. C., and in the majority of cases the addition of this element to other metals results in the raising of the melting point. This is clearly seen in the case of the nickel-copper alloys, in which series the melting points of the alloys increase practically proportionately to the addition of nickel. They therefore differ in this respect from the ordinary foundry brasses and bronzes, which all melt at a lower temperature than copper.

Before dealing with the high melting-point alloys, it might be worth while taking one of the well-known materials, such as gun-metal of Admiralty composition, and summarising some of the main points so that the differences in founding technique may be more apparent.

Possibly the most important factor in the production of sound castings in A.G.M. is the casting temperature. This will, of course, vary to some extent with the size and nature of the casting to be made, but for the majority of cases the best results are obtained by pouring within the range of 1,120 to 1,270 deg. C. If poured from temperatures outside this range, and especially if from higher temperatures, then the chances are the castings will be unsound. An A.G.M. charge can be raised to an unnecessarily high temperature and yet if allowed to cool before pouring still result in sound castings, but there is another point to watch, namely, the loss of zinc. The higher the temperature the greater the loss.

De-oxidation is generally effected by means of zinc, and is carried out before the tin is added. If not, then the tin may do the work of de-oxidation, and as tin oxide does not as readily separate and rise to the surface as zinc oxide, it may pass into the mould. The order of addition of these two metals is therefore important. The temperature required to melt and superheat this alloy can readily be obtained in ordinary coke-fired crucible furnaces, and during melting it is not essential to add a flux to form a slag on the surface, but a charcoal covering is often used to minimise oxidation.

Apart from the melting of the metal, there are other factors to be taken into account and allowed for in the preparation of the moulds, one of these being the liquid shrinkage, this term being taken to mean the decrease in volume occupied by the metal when cooling and changing from the liquid to the solid state as distinct from contraction. The contraction refers to the alteration in dimensions of the solid metal on cooling from the solidifying temperature to room temperature and is allowed for in the preparation of patterns. Measurement of the contraction allowance is a comparatively simple matter, being approximately ⅛ in. to the foot in the case of gun-metal. It is not, however, such a simple matter to gauge the liquid shrinkage, which is of considerable importance in fixing the sizes of gates and feeding heads to be employed and is largely a matter of experience. Some idea might, however, be obtained from the solidifying range. In the case of A.G.M. this extends over a range of about 200 deg. C. The sizes of gates and heads required for this metal are, of course, well known. Bearing these points in mind, an endeavour will be made to indicate similar features in alloys, which come within the following series:—"Nickel-silvers" (alloys of nickel, copper and zinc), nickel-copper alloys and nickel-chromium alloys.

Furnaces.

As far as the melting and super-heating is concerned, the furnaces which would most readily attain the required temperatures are electric furnaces of the Héroult type or induction furnaces. Where large quantities are required, these are used for nickel-copper alloys containing about 45 per cent. nickel and over, and for nickel-chromium alloys, but for melting for the production of relatively small castings crucible furnaces must be generally employed. These may be natural or forced-draft coke-fired furnaces, gas or oil fired, and regenerative. Natural-draft coke-fired furnaces are mostly used for the production of castings. Provided a strong draft is available and good quality coke is used, they prove satisfactory, but some form of forced draft, of course, provides more rapid melting, which is an advantage, as the shorter the period the metal is exposed to furnace gases the better.

The rate of melting is a factor of great importance, and melting should be carried out as quickly as practicable. The furnaces in which most variations are likely are, of course, the natural-draft coke-fired ones, and, therefore, these require added attention. In foundries where high melting-point alloys are not being continuously produced, they should not form the first charge of a day. By melting, say, a heat of brass or bronze, the furnace gets a chance to be thoroughly heated up. In general, the following procedure is satisfactory. Before charging any metal the crucible and coke bed are brought to a bright red heat. When this stage is reached, fresh fuel is charged, a good deep bed of coke being provided beneath the crucible. As much of the metal charge as possible is then put in at once, and, if practicable, the full charge. Once this is done, the furnace cover is kept closed, except for refueling, until the charge is melted and superheated.

In the choice of crucibles the smallest size which will take the charge should be adhered to. In many cases it is often advantageous to use two or more small crucibles for melting the metal for fairly large thin castings, which have to be run from two or more gates. Also, when a number of small castings have to be cast, it is better to cast from small crucibles, as these

* A Paper read before the London Section of the Institute of British Foundrymen, Mr. J. W. Gardom presiding. The author is in the Research and Development Department of the Mond Nickel Company, Limited.

alloys, having high melting points, cool down more rapidly than ordinary brass or gun-metal. By this means wide variations in pouring temperature are avoided, and castings of more uniform strength and surface finish are obtained. In short, every possible means should be adopted to keep the furnace and charge hot, and also to avoid prolonged melting periods.

For the "nickel-silvers" and lower nickel, nickel-copper alloys, a good-quality gas coke can be used, but for the others, to obtain fairly rapid melting with coke, it is advisable to employ a more lasting type, such as beehive coke. This is of a hard nature, and generally in fairly large pieces. When using it, care is required when poking down the fuel to avoid damaging the crucible, which may be plastic at the casting temperatures required, depending on the type used. The sulphur content of the fuel should be low.

In general, there are two main types of crucibles employed, namely, graphite and carborundum, the former being the most widely used. Compared with the life obtained in brass melting in graphite crucibles, the number of heats of high nickel-content alloys is comparatively small. In the case of the 45/55 nickel-copper alloy, for example, when melting in

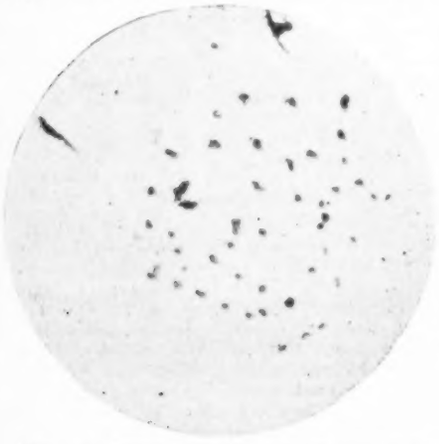

Fig. 2.—Showing Globular Graphite in the Alloy "Everbrite," taken from test-piece 1A. × 350, Unetched.

ordinary 130-lb. graphite crucibles, about 14 heats are usual. While it might not be safe to melt more of this metal, yet the crucible will be suitable for further melts of a lower melting-point material. With super-rapid crucibles, up to 18 heats have been obtained under similar conditions, but with this class of crucible, while they heat more quickly, they also cool more quickly, and this is a distinct drawback to their use. In the case of "nickel-silvers," in 100-lb. pots, about 20 heats are quite ordinary in graphite crucibles, while under the same conditions up to 84 heats have been obtained in carborundum crucibles. These latter can also be advantageously used for the lower nickel, nickel-copper, alloys containing, say, about 20 per cent. nickel.*

The necessity for high furnace temperatures means a more rapid wear of the furnace lining. When running on these alloys for any length of time, this raised the question of suitable refractories. The life of the ordinary firebricks set in with fireclay cement, which is in the normal course of foundry work is quite satisfactory, is rather short, and frequent patching and relining is required. More refractory linings are, therefore, called for. For this purpose "Silliminite" bricks, set in with silliminite cement, have given a longer life than firebricks. There are, of course, other types of linings which will possibly be equally satisfactory, but it is known that this particular make has proved an advantage.

* Since delivering this lecture, the author has intimated that further information has come to hand indicating that greater numbers of heats are being obtained when melting "nickel-silvers" and nickel-copper alloys in graphite crucibles, than those referred to above.

Melting Procedure.

As the melting technique for the various materials under consideration varies slightly, they will be dealt with under the different groups already mentioned.

Nickel-Silvers.

The oldest known alloys of nickel are the nickel-silvers, and those of higher nickel content come under the class of high melting-point alloys. As in the case of gun-metal, control of the pouring temperature is of great importance. This is shown in Table I.

Table I.—*The Influence of Casting Temperature on the Properties of a Nickel-Silver containing 15.9 per cent. Nickel and 55.6 per cent. Copper.*

Casting temp. C.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent.	R.A. Per cent.	Brinell hardness.
1,260	8.56	14.4	23.5	27.6	73
1,180	9.84	18.5	39.0	42.0	73
1,120	8.92	9.24	6.0	11.6	72
1,080	7.24	8.29	8.5	13.6	67

These tests were made on bars cast in sand at regular intervals between 1,260 deg. C. and 1,080 deg. C. From the results it is seen that the casting temperature should be controlled between close limits, a drop in temperature of 60 deg. C. from 1,180-1,120 deg. C. resulting in approximately 50 per cent. reduction in the maximum stress values.

The melting of nickel-silvers for castings is generally carried out in coke-fired crucible furnaces, but for larger quantities, induction furnaces may be employed. Typical melting time for a 20 per cent. nickel alloy in natural-draft coke-fired furnaces is 1¼ hours for a 100-lb. melt, the coke consumption being 0.56 lb. per lb. of metal. The charge may either be made up from ingot metal of the required composition or from pure metals, generally, together with a proportion of scrap. If made up from new metals, in cases where rapid melting is not possible, instead of using pure nickel, it is advisable to add the required amount of nickel in the form of a nickel-copper shot containing, say, 50 per cent. nickel, which will melt more readily. The melting time may also be reduced by charging a portion of the zinc, say about half at the beginning. When this is done, allowance must be made for increased loss of zinc. The remainder of the zinc is charged shortly before pouring.

Suitable fluxes for nickel-silvers are an 80/20 mixture of borax and boracic acid, or a flux known as "Borocalcite," the latter being preferred. The former forms a very fluid slag, which is rather difficult to skim clean, but this can be assisted by throwing some dry parting sand on the surface for final skimming. "Borocalcite" is slightly less fluid, and, being more nearly of a neutral composition, does not attack the pots so much at the slag line.

The de-oxidation of these alloys is carried out by an addition of about 2 ozs. of manganese to 100 lbs. of metal before drawing the crucible. For the higher nickel-content nickel-silvers it is sometimes advantageous to make a small magnesium addition as well as the manganese; the reason for such addition will be dealt with under nickel-copper alloys.

Nickel-Copper Alloys.

These form the basis of a wide range of alloys, typical examples being 80/20 cupro-nickel "Everbrite," containing approximately 31 per cent. nickel; "Silveroid," containing 45 per cent. nickel; and "Monel metal," containing approximately 68 per cent. nickel. As the treatment of the metal differs slightly with increasing nickel content, these alloys will be dealt with separately, but before doing so it might be advisable to consider the effect of some elements on nickel, which result in the necessity for various addition agents.

Pure nickel, when molten, readily takes up oxygen, carbon and sulphur to form nickel oxide, nickel carbide and nickel sulphide. The formation of each of these, if allowed to remain as such in the metal, would have a deleterious effect on it, and precautions must, therefore, be taken to prevent, as far as possible, their formation, and/or to reduce or convert them to some less harmful form.

The nickel oxide formed when nickel is melted in the presence of oxygen melts at 1,660 deg. C., and, therefore, solidifies before the nickel. When present in the solid metal, it is in a very finely-divided state, and does not substantially embrittle it.

The effect of carbon is more marked. Nickel carbide, which contains 6.38 per cent. carbon, melts at 2,100 deg. C., and it forms an eutectic with nickel at 2.2 per cent. carbon. If the carbon remains in the combined state, it simply results in a slight increase in hardness of the metal, but when nickel or high nickel-copper alloys containing considerable amounts of carbon are exposed to prolonged heating, this carbide

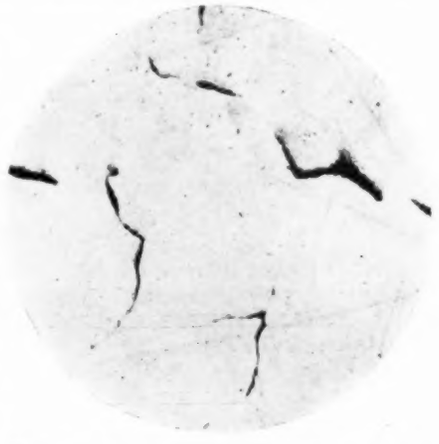

Fig. 3.—Showing Flakey Graphite in the Alloy "Everbrite," taken from test piece 4A. × 350, Unetched.

breaks up, forming free carbon or graphite. When this takes place the metal is considerably weakened.

Considering the readiness with which nickel combines with carbon, it might be thought that its alloys should not be melted in graphite crucibles. Nickel more readily takes up carbon from carbonaceous gases than from solid carbon, and graphite is the most refractory form of carbon. Further, the surfaces of contact of crucible and metal are out of contact with air or oxygen. Little carbon pick-up, therefore, comes from this source.

Nickel sulphide forms an eutectic with nickel at 21.5 per cent. sulphur, which melts at 644 deg. C., and, therefore, remains liquid for some time after the mass of nickel or nickel alloy has solidified. From tests* carried out by P. D. Merica and R. G. Waltenberg, the solubility of this compound in nickel must be extremely small. When present, it takes the form of films partially or completely surrounding the grains of metal, and is the most embrittling of these three compounds.

To prevent these deleterious effects, various additions are made to the metal before pouring. The chief of these is magnesium. This element has a greater affinity for sulphur than has nickel, so, when added, it reacts with the nickel sulphide to form nickel and magnesium sulphide, and this latter form is much less harmful. It is solid at

* Technologic Papers of the Bureau of Standards No. 281.

a temperature of about 1,460 deg. C., and is found in the metal in the form of isolated crystalline particles entrapped when the metal solidifies. Magnesium has also a strong affinity for oxygen, and, if the nickel or nickel-alloy is not previously deoxidised, then it will react with the oxide, with the risk of inefficient desulphurisation. To avoid this, deoxidation is first carried out by manganese or silicon additions. Manganese has also an affinity for sulphur, and the latter forms an eutectic with nickel, melting at 1,325 deg. C. Its distribution in the solid metal, although along the boundaries, is less harmful than nickel sulphide, as it is in the form of globules. On subsequent magnesium addition, this metal, having a higher affinity for sulphur than manganese, reacts with manganese sulphide to form magnesium sulphide.

Magnesium also reacts with oxides, forming magnesium oxide, and generally has a degasifying effect on the metal. It reacts particularly with carbon monoxide, a gas which nickel readily absorbs. If thorough deoxidation and degasification is not effected, then, on solidifying, the metal will be porous and contain blowholes, due to decreased solubility of gas in the solid. As the nickel alloys set quickly, these gases will be trapped.

When making magnesium additions, special precautions are required to ensure that it is retained in the melt. If simply thrown on the surface, then as it readily burns, when in contact with air at high temperatures it simply flares away and has no effect on the metal. The general method adopted is to attach the magnesium, 1 in. dia. rod being a convenient size, to an iron rod, either by bending the latter round it or by drilling a hole in the magnesium and forcing the end of the iron rod into it. By this means it can be held beneath the surface of the melt until reaction is complete, which only takes a few seconds.

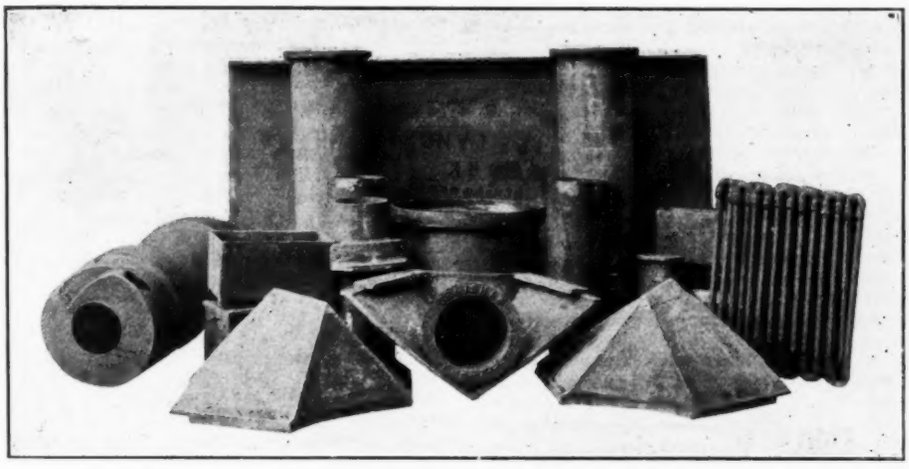

Fig. 4.—A Group of Castings made in "Cronite."

Reverting again to the melting procedure for the nickel-copper alloys already referred to and taking the 18/20 cupro-nickel first, this alloy is generally melted in natural-draft coke-fired crucible furnaces. A typical melting time is 1½ hrs. for 100 lbs. charge.

For this composition a stick-charcoal covering may be used, as the risk of carbon pick-up is slight unless the metal is raised to unnecessarily high temperatures in the furnace. Deoxidation is carried out by the addition of about 1½ to 2 ozs. of manganese before drawing the crucible, the manganese being thoroughly stirred into the melt. In this case a magnesium addition is not essential unless the scrap-content in the charge is high.

When the nickel content reaches 30 per cent., precautions should be taken to prevent contact between the metal and furnace gases, especially carbonaceous and sulphurous gases. A charcoal covering should not, therefore, be used, but instead a flux similar to those already mentioned for "nickel-silvers."

As illustrating the effect of carbon pick-up on the strength of nickel-copper alloys, the following test results taken from two heats of "Everbrite" are interesting. A typical analysis of this alloy is as follows:—Copper 61.88, nickel 31.02, iron 6.11, silicon 0.59, manganese 0.33, carbon 0.50 and sulphur 0.015 per cent.

The charges in each case were 100 lbs., and were melted in natural-draft coke-fired crucible furnaces, graphite crucibles being used. For the first melt A, the melting time was 4½ hrs., and for the second melt B the time was 3¾ hrs., both being at least twice as long as the time normally required to melt this alloy in good going furnaces. The same deoxidiser was used in each case, namely, ¾ oz. magnesium and the same flux, in these particular instances a half-and-half mixture of borax and boracic acid. In charge B ¾ lb. of manganese oxide was added to keep down the carbon content. The dimensions of the test-pieces cast are shown in Fig. 1. Test-pieces Nos. 4A, 7B, 1A and 6B were provided with feeding heads, while No. 3A had no provision for feeding. The analysis of the two melts differed only in carbon content, A containing 0.16 per cent. carbon and B containing 0.05 per cent. carbon. Drillings taken from test-pieces 1A and 4A were tested for free carbon. The metal in 1A contained 0.138 per cent. in the form of fine specks, and in 4A 0.124 per cent. free carbon, but more in the form of flakes. The accompanying photomicrographs, Figs. 2 and 3, at 450 dias., were taken from sections of 1A and 4A respectively. Analysis of drillings from melt B proved the absence of free carbon.

The test results are shown in Table II.

Table II.—*Tensile Test on Two Casts of "Everbrite."*

Remarks.	Test-piece No.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent. on 2 in.
¾-oz. Mg per 100 lbs. added in each case and same flux used	1A	26.9	34.9	9
	4A	24.8	26.3	5
	3A	—	20.9	1
¾-lb. Mn oxide added to charge for Melt B	6B	28.0	40.7	13
	7B	26.8	39.2	12

From these it will be seen, firstly, the presence of free carbon in the finely divided form lowered the maximum stress by, roughly, 6 tons per sq. in. Free carbon in the flaky form had a still greater effect, lowering the maximum stress by, roughly, 14 tons per sq. in. The elongation was also decreased. Melt A is, of course, a particularly bad example of what may happen. In all high nickel content alloys special attention is required to control the carbon content. Test-piece No. 3A shows the combined effect of free carbon and want of adequate feeding.

While the addition of manganese oxide was made to the "Everbrite" charge B to help to keep down the carbon content, yet this is generally not necessary under quick-melting conditions, especially with alloys containing less than 50 per cent. nickel. Take the case of "Silveroid," which has a melting point just over 1,200 deg. C., and which requires a pouring temperature of about 1,400 deg. C.; for casting purposes it is generally melted in natural-draft coke-fired furnaces, a typical melting time being 1½ hrs. for a 130-lb. charge. Provided a fluid flux such as "Borocalcite" is added to form a slag covering and all coke is kept out of the crucible by means of a lid of some kind, then little carbon absorption takes place. The addition agents generally added to "Silveroid" for deoxidation purposes are manganese or silicon and magnesium. It is general to add about 1½ to 2 ozs. manganese to 100 lbs. of metal, and this is done about five minutes before drawing the crucible from the furnace. After drawing, approximately ¼ oz. of magnesium per 100 lbs. is added. If silicon is used in place of manganese, then the quantity used requires consideration. For purely deoxidation purposes about 0.2 per cent. is sufficient, and if quantities over 1 per cent. are added, then, while the metal may be made more fluid, it has a marked hardening effect. In fact, the addition of silicon as a hardener to nickel-copper alloys has formed the subject of patents taken out by M. S. Corson, the American metallurgist.

For the melting and superheating of Monel-metal casting, a furnace temperature in the region of 1,700 deg. C. is required, as this alloy melts at, approximately, 1,360 deg. C., and requires to be superheated to about 1,500 deg. C. for pouring. Melting can be, and is being, done in coke-fired furnaces, but a strong draft is essential. As nickel more readily takes up carbon at high temperatures, when melting this metal in these furnaces, it is general and advisable to add an oxide with the charge to keep down the carbon content. For this purpose about 1½ lbs. of manganese ore are placed in the bottom of the crucible along with the first of the charge, and this also forms a slag covering for the metal. If no ore is added, then a flux is necessary, as in the case of "Silveroid." To deoxidise Monel metal, manganese or silicon, but preferably the latter, and magnesium are added. When the metal has been brought to the required temperature, about 12 ozs. of silicon per 100 lbs. are thoroughly stirred into the melt. If the stirring is not done then, the silicon may remain on the surface and will not perform the function of deoxidation, for which it was added. The addition of this element raises the temperature of the metal. Just before drawing the crucible, about 1 oz. of magnesium per 100 lbs. is added, and after drawing a further 1 oz., but the exact quantity will vary with the condition of the melt. The addition of magnesium to molten Monel metal has the effect of making it less fluid, and for this reason the minimum amount necessary should be used. The metal should also be at a sufficiently high temperature before drawing from the furnace to allow for this.

When melting large quantities, this is more readily done in electric furnaces, and in these better control of the melting conditions is possible. In electric arc furnaces, for this purpose a basic lining is generally employed, and the charge is melted under a slag covering composed of lime, sand and fluorspar, about 60 lbs. per 13-cwt. charge. The exact amounts of these constituents are regulated according to the condition of the slag. The addition of fluorspar, which melts at approximately 900 deg. C., has the effect of making the slag more fluid. If,

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however, much is added, it has a corrosive effect on the furnace lining. The carbon content can be most readily controlled in this type of furnace. If the carbon is high, then it can be oxidised out by opening of the furnace doors and allowing free access of air, or by the addition of, say, manganese ore to the melt. If carbon is too low and the bath goes wild, then carbon can be added in the form of coke breeze or small pieces of anthracite. For castings, the carbon should not be below about 0.15 or over 1.3 per cent.

Nickel-Chromium Alloys.

In the nickel-chromium series are found the highest melting-point non-ferrous alloys commercially employed for making castings. Typical examples of these are "Nicrite," containing 80 per cent. nickel, and "Cronite," containing approximately 68 per cent. nickel and 12 per cent. iron. The former melts at about 1,380 deg. C., while the melting point of the latter is rather over 1,400 deg. C. The obtaining of good sound castings in these alloys, therefore, demands the utmost attention to detail in all stages of melting and moulding. The fact that the founding technique for these materials has been successfully developed is clearly shown by Fig. 4, which shows examples of castings made in "Cronite." These are part of the normal run of castings, but more intricate work also enters into the daily production.

Both these materials can be melted in coke-fired pit furnaces with strong natural draft, or forced draft, but the melting period is rather long. As pouring temperatures of between 1,600 to 1,700 deg. C. are required, electric furnaces are naturally most satisfactory. As in the nickel-copper alloys, the carbon content is of importance. With chromium present, however, in quantities, as in the materials being considered, there is less risk of the carbon being present in the free state, as chromium tends to hold the carbon in solution.

During melting, similar precautions to those already mentioned are taken, and for deoxidation manganese and/or silicon and magnesium are added.

Remelting.

In practically all charges for castings scrap or remelted ingot metal forms a part, and in all high nickel-content alloys the quantity used should be carefully controlled. It must be remembered that the oftener these materials are remelted, the more carbon and sulphur they are likely to contain, specially the latter, as some control can be exerted over the former. Further, on remelting, similar quantities of addition agents are required, as for new-metal charges, since, on melting, the sulphur will again combine with the nickel, reforming nickel sulphide, which requires a fresh addition of magnesium before pouring.

Shrinkage and Contraction.

The contraction allowance for the alloys under consideration is approximately $\frac{3}{16}$ in. to $\frac{1}{4}$ in. per ft., as compared with $\frac{1}{8}$ in. per ft. for gun-metal.

The liquid shrinkage is a property which cannot readily be measured, but this factor enters into the question of the sizes of gates and feeding heads required. The sizes necessary for gun-metal are generally well known, and some little comparison might be got from the differences in solidifying ranges. The solidifying range for gun-metal is of the order of 200 deg. C., that of cast iron, roughly, about 150 deg. C., and about 30 deg. C. for steel. The 80/20 nickel-chromium alloy has a range of 60 deg. C., the 70/30 nickel-copper about 35 deg. C., the 45/55 and 30/70 nickel-coppers about 70 deg. C., and the 20/80 nickel-copper about 60 deg. C. The shorter this range is, the more rapid will be the draw on setting, and a sufficient volume of fluid metal must be almost instantaneously available to supply the want. This means increased size of feeding risers, both in cross-section and height. The cross-section governs the quantity of metal which can pass through in a given time, and the height regulates the pressure.

Special detailed attention is necessary in placing feeding risers, and the three well-known governing principles must be kept in mind, namely:—(*a*) The sink head must be made heavy enough to remain molten in its interior longer than the section of the casting to be fed; (*b*) the section of the neck of the feeding head must be such that this neck will not set before the section of the casting to be fed, or the feeding head itself; this however, receives heat from the head and from the casting, and can, therefore, be a smaller section than the head; and (*c*) fluid pressure is dependent on the height of the column of fluid and not on the volume, and is equal in all directions.

In the design of castings to be produced in high melting-point alloys this property of high-liquid shrinkage should always be borne in mind and metal sections made uniform wherever possible. Further, all sharp corners should be avoided. This, of course, applies to castings in all materials, but more especially to those similar to the ones under consideration.

Moulding.

In the choice of sands and preparation of the mould the high casting temperature required and quick freezing must be borne in mind, as well as the shrinkage and contraction. Highly refractory sands are necessary, and these should be free venting to allow of the rapid escape of air and gases through the mould, this also being kept in mind while ramming. Free use should be made of the vent wire to assist this.

For nickel-chromium, nickel-copper and "nickel-silvers," Worcester, Birmingham Red, Belfast Red, Mansfield Red and Erith sands are used.

As is well known, the chief refractory constituent is silica, iron oxides and alumina acting as binders. The alkalis soda and potash really act as fluxes, and should therefore be at a minimum. The loss on ignition gives some idea of the amount of clay matter present. Apart from the chemical composition, the physical nature of the sand is very important. The grains should be round and fairly uniform to prevent too close ramming.

Cores.

In the making of cores, the essential features are refractoriness of the sand employed and very high permeability to air and gases. Oil-sand cores are successfully used, and very good metal surfaces obtained. These alloys set quickly, and have not such a searching action on the sand as might be expected when one first considers the high casting temperatures required. Cores should, of course, be collapsible to allow of free contraction.

Facings.

The most generally used facing material for these high melting-point alloys is plumbago, either alone or mixed with loam, china clay or molasses, the quantity of loam or china clay depending on the particular alloy to be cast.

Chaplets.

Wherever practicable, the use of chaplets should be avoided, but in some cases this is not possible. As castings made in high nickel-content alloys are often required for resisting high temperatures or corrosive action, the chaplets used should be of the same metal as the rest of the casting. Even with these high melting-point materials satisfactory union between the chaplet and body of the casting is obtained.

Conclusion.

Such are some of the features peculiar to nickel alloys; some foundrymen may already have experienced some of them, while others may meet them at some future time. It is hoped, therefore, that the data outlined will prove of some little assistance in the handling of these materials in the foundry.

Modern Cast Irons.

IMPROVED PROPERTIES.

At a meeting of the Diesel Engine Users Association held at Caxton Hall, Westminster, London, on November 1, Mr. J. G. Pearce, M.Sc. (Director, British Cast Iron Research Association), read a Paper on "Modern Engineering Cast Irons and their Properties," in the course of which he pointed out that the general specification for cast iron issued by the British Engineering Standards Association in 1928 embodied several novel features in testing cast iron, including the principle of the separately-cast test-bar; the use of both tensile and transverse tests; the adoption of the cylindrical in place of the square or rectangular bar, and the use of test-bars of varying diameters corresponding to the main cross-section of the casting. The use of strictly standardised bars provided a basis of comparison between one foundry and another.

If a series of bars of varying diameters were cast from a given foundry mixture, the smallest bar, provided it remained grey, was strongest, and the specific strength then diminished continuously as the section increased. The specific strength might be tensile, compressive, transverse or torsion. In the case of the transverse test, the central breaking load was conveniently converted into a rupture modulus by the usual beam formula. The ratio between the transverse and tensile strengths varied according to the nature of the iron, being greater for the weaker and less for the stronger irons, the maximum range of variation being 1.65 to 2.25. For ordinary engineering irons, however, the ratio was 1.8 to 2, and the ratio of compressive to tensile strength was about 4.

Cast iron, continued the author, behaved much better under fatigue tests than might be expected. From experiments carried out in America the endurance ratio (ratio of endurance limit at one hundred million reversals to tensile strength) varied from 0.33 to 0.50; an excellent figure when compared with those for wrought iron and steel. The endurance limit could be raised about 33 per cent. by systematic understressing, and holes and grooves and other points where a local stress concentration existed did not reduce the fatigue strength as was anticipated from experience with steel.

Influence of Melting Conditions.

Experience had created controversy on the best type of structure to withstand wear and upon the most desirable composition. Some of these differences were doubtless due to the effect of melting conditions. Metallurgists had for some time appreciated that the structure of cast iron, which determined its mechanical properties, was governed in part by composition and in part by rate of cooling. From recent work carried out by the Cast Iron Research Association it was established that a third factor had to be added, *i.e.*, melting conditions. By suitable variation of melting conditions it had been possible to obtain entirely different structures from the same composition. These conditions covered the nature of the constituents of the charge as distinct from composition, cupola design and running conditions, fuel and so on. The multiplicity of these variables explained the enormous difficulty of the founders' task.

Outlook for U.S. Steel Industry.—Mr. Charles M. Schwab, Chairman of the Board of the Bethlehem Steel Corporation and President of the American Iron and Steel Institute, in his address at the recent opening of the autumn meeting of the Institute, told the members that he had never known the American steel industry to enjoy greater stability or more promising outlook than it does to-day.

Cupola Refractories.

LONDON DISCUSSION DISCLOSES FRESH POSSIBILITIES.

Cupola Refractories and Cost of Castings.

The Branch-President, opening the discussion, said that the cost of refractories, as compared with that of the iron and labour in making a mould, was comparatively small, but the effect of refractories upon the making of good castings was very important. Mr. Presswood had stated that the human element was a very important factor, and the fact that the production of good castings was so dependent upon this human element was an indication that we had very little knowledge of refractories and their use. He would like further information as to the real nature of the actions which spoiled the cupola linings. With regard to the problem of the use of two or three different types of refractory materials in the cupola, he said it was sometimes considered necessary to use special bricks up to the charging door in order to minimise the abrasive action due to the charge bumping against the sides. He would have liked figures as to the cost of refractories per ton of castings produced.

Glazing of Refractories.

Mr. C. H. Kain referred to the softening point of linings. Foundrymen, he said, were often offered materials, the melting temperatures of which were said to be astonishingly high. They were not particularly interested, however, in the melting temperature of bricks for use in a cupola, because they could not possibly attain that temperature, but the softening point was very important, particularly as it fell very rapidly with an increase in pressure. The cupola was a rigid, iron cylinder, and the lining was built inside and heated very fiercely, so that naturally there was great expansion and a great increase in the pressure exerted upon the linings, and the softening point would fall. When the linings became soft, they began to be badly cut about. He was very glad that the refractory producers were tackling the problem from that point of view instead of from the point of view of melting temperature. He was rather disappointed, however, that Mr. Presswood had not emphasised more particularly the importance of having a good surface on the bricks or the lining. In basic steel furnace practice he had found it was most important to have a smooth face on the brick, and had gone so far as to paint the bricks with fluxing material in order to produce a glaze. When the bricks, including the joints were well glazed over, the penetration of vapours was prevented, and the life of the bricks was lengthened. Again, if the bricks were well vitrified and glazed, the charges would naturally slip down better, and scaffolding would be eliminated. With regard to the consumption of refractory materials, he said he had read in The Foundry Trade Journal that in some of the German foundries the refractory consumption was something like 2 per cent. of the metal melted, and in the case of long runs the percentage was as low as 0.9. He asked if Mr. Presswood had figures relating to English practice for the purpose of comparison with the German figures.

Temperature to be Withstood.

Mr. V. C. Faulkner, discussing the cupola temperatures, said he imagined that if one placed in the hearth of an ordinary cupola a series of crucibles containing Swedish iron, and put the blast on the cupola, one would find that one could melt Swedish iron inside it. That would establish that the temperature was much higher than most people imagined, and it was wrong to say that because we were melting iron and not steel, therefore the temperature was low. Somebody had said that a temperature of 1,900 deg. C. might be reached in a cupola; that was possibly wrong, but he did consider that one could very easily reach a temperature of 1,700 deg. C., which was the melting temperature of most bricks. Discussing the attack on the walls of furnaces, he said that, although Mr. Presswood had dealt with the effect of lime and silica, he had ignored the effect of ferrous oxide, which was a very strong base and which could attack the walls very easily. With regard to the glazing of bricks, apparently Mr. Kain had not realised that a glaze was imparted to the bricks in high temperature furnaces for the purpose of reflecting the heat rays emanating from the arc.

Effect of Continuous Working.

Mr. A. S. Beech agreed with Mr. Presswood that the life of refractories in a cupola depended a great deal upon the human element, and added that it depended particularly upon the method of operation of the cupola. Reference had been made to the emission of blue flames from the top of a cupola. A well worked cupola, however, should never emit flames; if combustion occurred in parts of the cupola other than the melting zone, the effect upon the lining was bad, so that one must always endeavour, therefore, to work the cupola so that the combustion occurred in the melting zone. The melting zone tended to be lower or higher, according to the height of the coke above the tuyeres, so that it was necessary, therefore, to check the height of the coke in order to maintain it at the proper level if the cupola were to be worked efficiently. The variation of the height of the melting zone must have a bad effect upon the lining of the cupola. In view of the great interest which was being taken in continuous working, he asked whether the use of a cupola continuously for the whole of an 8-hour day, instead of for a period of 4 or 6 hours per day, as at present, would have a very bad effect on the lining.

The Branch-President: At the same rate of melting per hour?

Mr. Beech: Yes.

Gas Resisting Refractories.

Mr. J. Deschamps asked how much coke of a particular calorific value would be required to transform into slag, say, 1 cwt. of the ordinary fireclay lining of a cupola, his point being that if we could find out what was the cost in coke, it would provide an incentive to improve on the linings of cupolas. He also asked for information as to the composition of refractories which would resist the effects of carbon monoxide.

Tensile Strength Considerations.

Mr. S. V. Williams, discussing the testing of refractories, said that in the glass industry much useful information had been obtained by subjecting refractories to a tensile test. In this test a rod of the refractory material, about ½ in. square, was loaded in tension and heated up until it broke. The test gave an indication of the softening temperature in the same way as the compression test, but it had the added advantage that quite a lot could be learned from the nature of the fracture. In some cases the fractures were close and fined grained, and in others were of a fibrous nature. It also gave some measure of the amount of glassy material which was present or which was formed when the material was heated. With regard to sillimanite, he said that, despite its cost, it was extensively and successfully used in the glass industry.

Limestone Additions need Controlling.

Mr. Thomas Singleton commented upon the fact that certain refractory materials for cupola work gave very satisfactory results in some places but not in others, as, for instance, the Sheffield ground ganister. Generally speaking, many of the founders in the Black Country were wedded to the pocket ganisters, to which Mr. Presswood had referred. In the North East of England there were some people who were rather keen on the Scottish type of ground ganister, which was certainly much more plastic than the ordinary Sheffield grade. The proportion of silica stone seemed lower, and the material was of a nature more nearly approaching the fireclay linings mentioned by Mr. Presswood. An important point to which attention should be paid was that of the action of the limestone as a flux on the linings. Generally, so far as he could see—and he said this with very great reservation—the amount varied within fairly considerable limits, but it must be obvious that the lime had to be satisfied somewhere, and if not anywhere else it would get it out of the linings if there were any free silica there. That was a very good argument for a neutral lining with the 40 per cent. alumina bricks, and, in his view, that was very near the ideal lining. The problem of the amount of limestone which was added as flux was one which required very careful consideration always. At a meeting he had attended recently a lecturer had stated that it was usual to weigh the limestone. In consequence of this he (Mr. Singleton) had obtained permission to ask how many of those present at the meeting adopted the practice of weighing the limestone, and only one out of 30 or 40 had said that they did so. He was in agreement with Mr. Presswood as to the use of two or three different classes of material in a cupola. Obviously, there were at least two definite zones—the melting zone and the higher one nearer the charging door—and whilst a certain patching or ramming material might do quite well for the melting zone, it did not necessarily follow that it would be suitable for the zone higher up. There was a certain temperature at which the material attained a glaze, and the glaze might be obtained in the melting zone, but not higher up, or vice versa.

Spalling and Venting.

Mr. Gibb, referring to the glazing of bricks, said that an old furnaceman at his foundry, who had had about 60 years' practical experience of cupolas, had always insisted upon a preliminary heating for the purpose of glazing the bricks, and practical experience had proved time after time that that was a paying proposition. He looked forward to the day when there would be produced a neutral lining which would last for years. With regard to spalling, he recalled occasions on which, when certain types of lining were used, he had noticed explosions somewhat like the reports of guns inside the furnace. When the next furnace was lined up, therefore, he had investigated the matter. The fire was lighted up very gently, and he had inspected the interior of the furnace through the tuyere holes, and also by looking down from the top, and had found that the lining was cracking and that pieces were coming off. On the following day he had insisted upon the furnaceman venting the ganister or fireclay, and had found that that venting had eliminated the spalling effect. Therefore, he agreed with Mr. Presswood that some firebricks were too dense, and the ideal lining was one which must not be too dense or too porous. He also agreed that furnacemen did almost invariably make the ganister or other lining material too wet. Again, his experience had proved that it was good practice always to have one furnace as a standby.

Value of Coke Additions.

Mr. H. G. Summers asked Mr. Presswood for his opinion as to the value of mixing ground coke with ganister for patching. He had lined and patched cupolas, he said, with ganister with which he had mixed 30 per cent. of ground coke, and the results had been better than those obtained when the ganister was used without coke. He had never put coke breeze behind the

lining, because of the contraction which occurred after expansion. The shrinking would tend to belly the cupola and make the conditions much worse than otherwise.

Author's Reply.

Mr. Presswood, replying to the discussion, said he could not give figures as to the cost of refractories per ton of castings produced, as he had implied in his Paper. He felt, however, that figures of cost per ton constituted the true basis of exchange of service between customer and supplier. Obviously, a supplier could not hope to get figures of cost per ton of castings of a reliable nature except from users, and he urged that it was in their own interests that the users should attempt to standardise some method of measuring the cost per ton of castings. It was quite easy for a supplier's representative to call on one firm and suggest that other firms were using the material satisfactorily on, it might be, a similar class of work; he might be able to point to a small price reduction; but that did not mean that these other firms were getting results, based on cost per ton of castings, which would satisfy the prospective customer. There was very little basis on which one could buy a lining, except on that of past experience, and that experience must be in terms of cost per ton of castings.

Glazed Linings.

With regard to the question of the functions of a glaze, he certainly believed that in electric and reverberatory furnaces a glaze functioned as a reflector of heat waves. He agreed that old furnacemen were moved almost to tears if they could not get a glaze on the face of the brickwork. It was also claimed that a glaze definitely reduced spalling or cracking of a lining, and he believed that was of importance, especially in furnaces which were worked continuously. It must be remembered, however, that a glaze was really glass, and glass was extraordinarily sensitive to temperature changes; inasmuch as a cupola was worked day by day, and was shut down at night, the glaze might tend to crack, and from that point of view it might not be considered very valuable. At the same time, he maintained that it was valuable in a cupola, possibly for the reasons suggested by Mr. Kain, but largely because it strengthened the material. Even with some siliceous bricks and patching and ramming material a glaze was formed, behind which the material was hard. If the material behind were friable or soft, he did not think one would get good results, but certainly a glaze strengthened the material. With some siliceous materials there was a tendency for the fireclay to come to the surface to be melted and to form a glaze of a very special type. It was not sufficient, in trying to make a glaze on a furnace wall, to wash the face with something less refractory—a flux. It was far more valuable to form a glaze by slight overheating in the first case—a practice he had known used successfully in patching or lining. On microscopic examination, the glaze, even in the case of siliceous bricks, sometimes showed evidence of melting and recrystallisation. In the glaze there were found tiny needles, very often of mullite, which was related to sillimanite, but had rather better character, and certainly had the property of knitting together the surfaces in which it was crystallised; it had very little expansion and non-spalling properties. A glaze was very valuable, therefore, from that point of view. It was well known that on firebricks containing about 40 per cent. and upwards of alumina a glaze was formed readily, and that was really a new mineral—needles of mullite.

Dealing with Mr. Kain's question as to the consumption of refractory materials in relation to metal melted, he said he was not in a position to give definite figures, but he had heard one or two which suggested that the average in this country was about 3 per cent.

Ferrous Oxide as a Flux.

As to Mr. Faulkner's suggestion that no mention had been made in the Paper of iron oxides as a flux, he said he had referred to iron, and, from his point of view, when speaking of iron as attacking refractory materials, one really thought in terms of iron oxide. If there were any oxidation of the metal in the melting zone of the cupola, it would form the lower oxide or ferrous oxide of iron. Ferrous oxide was a very dangerous flux for refractory materials, and it was more seriously destructive of silica than of the type of fireclay he had spoken of—which was again an argument in favour of a fairly neutral type of fireclay or firebrick or composition lining.

Replying to Mr. Beech, he said he would not expect any serious difference in the condition of the refractories as between six-hour and eight-hour periods of continuous working. If day-to-day patching were relied on solely, and if it were found that the morning's patch were removed completely when the end of the blow was reached, there was danger in prolonging the period of working further, because the permanent lining was becoming thinner and thinner, and an increasingly larger patch was necessary each succeeding morning. He had suggested in the Paper that patches were too often removed during the early stages of blowing. If, however, a satisfactory patch was applied, only part of which would be removed in the course of the day's blow, continuous working for prolonged periods would not lead to very serious results—and from the point of view of refractory materials truly continuous working was beneficial. Alternate heating and cooling (and cooling as it was occasionally carried out, he was sorry to say, by water spray) was one of the most harmful treatments one could possibly give to refractory materials.

Replying to Mr. Deschamps, he said that, so far as he was aware—he had not read all the research literature—there had been no attempt made to measure the latent heat of fusion of firebrick materials. In the first place, the composition varied so very widely that a figure would not have a great value, and, secondly, the actual fusion in the cupola was effected largely by fluxes, which naturally affected thermal changes.

In the discussion the following reply to Mr. Deschamps, who asked for analysis of the blast-furnace lining bricks referred to in the Paper, was omitted, but was communicated to Mr. Deschamps afterwards by the lecturer.

As to analysis of blast-furnace linings resistant to carbon monoxide, analyses would vary, the essential point being that iron oxides were properly balanced by lime, so that there was formed a ternary or quarternary compound including iron oxide, lime, alumina and silica, this compound being unaffected by CO. One of the successful bricks has the following analysis:—Silica, 55.30; alumina, 37.09; ferric oxide, 2.29; lime, 0.62; magnesia, 0.83; alkali, 1.98; and titanium oxide, 1.72 per cent.

Tensile Strength of Refractories.

The tensile test applied to refractories, mentioned by Mr. Williams, was very valuable. It was applied to refractories used in the glass industry, because in that case one was dealing with a viscous glass in contact with a refractory material, and one of the troubles experienced was that the viscous glass pulled particles away from the lining, thus forming "stones." He did not know that any consideration of that kind had been applied to cupola linings, but with this in mind had referred in the Paper to the "tearing" action of the descending coke and the consequent need for high tensile strength of the material in the lining even at high temperature. Sillimanite was used with truly beneficial results in the glass industry, and its high first cost was more than justified, but in glass-melting furnaces there was practically no influence of iron oxides, to which he believed this material had proved to be peculiarly susceptible. When he had referred to the high cost of sillimanite, and one or two other refractories as applied to the cupola, he had had in mind that, as there was available a relatively cheap, fairly aluminous fireclay material which from many points of view looked like making an ideal lining, there was far more inducement to proceed with work on material of that character than to use materials the cost of which, in the form of ordinary square bricks, ranged from £70 to £100 or more per thousand. The cheaper materials should be explored first. At the same time, there was room for improvement in the quality of the existing materials which might be effected by the addition of small quantities—it might be 10 or 20 per cent.—of new materials, such as corundum, alundum and, maybe, sillimanite and mullite.

How Spalling Comes About.

He agreed with Mr. Gibb that spalling might be due to steam or air becoming locked up in a patch or lining, so that venting might relieve it. Careful drying was essential, not merely to avoid the effects of water shrinkage, but also because the water, if not removed, would be converted to steam when the material was heated, and could blow out the lining; in one or two cases of rammed linings, he believed, it had burst the shell.

Porosity and Coke Additions to Ganister Patchings.

The use of coke in ganister for patching was certainly beneficial. It tended to ease the passage of moisture during drying; ultimately it burned out and left a fairly porous patch, which tended to move with more freedom and without cracking. He believed it had been said that, when Huntsman had required linings for his new furnaces, he had found by accident that road scrapings gave very good results. It was the practice, before the introduction of tarred roads, to scrape a sludge or slurry off the roads as they then existed. In the Sheffield district years ago all road metal was referred to as "ganister," and "ganister" was known only as a road metal. Conceivably a little clay was added in binding the roads, and probably this was fireclay, so that the success achieved in those early days could be explained. The demand for linings was so great that an individual had hit upon the idea of manufacturing a similar material, and in the early stages of manufacture he had added deliberately horse manure, in an attempt to imitate road scrapings. That seemed humorous, and perhaps unnecessary, but, as a matter of fact, it had had a definite function. Horse manure, straw and the like definitely strengthened the material whilst it was green, greatly assisted drying, and ultimately burned out, leaving in the material a measure of porosity which was beneficial. That had a bearing on the successful use of coke in ganister, and he had heard of several other materials in which there was incorporated something combustible—coke or coke breeze, or the like.

Finally, Mr. Presswood expressed his appreciation of the manner in which his Paper had been received, and assured his hearers that it had been a pleasure to present it.

On the motion of Mr. G. C. Pierce, seconded by Mr. V. Delport, a hearty vote of thanks was accorded Mr. Presswood for his Paper.

Williams Prize of the Iron and Steel Institute.—The Williams Prize of the Iron and Steel Institute, of the value of 100 guineas, has this year been awarded by the Council to Mr. William E. Simons (assistant blast-furnace manager at the Cardiff works of Messrs. Guest, Keen & Nettlefolds, Limited), in consideration of his Paper on "The A.I.B. Sinter Plant at the Works of Guest, Keen & Nettlefolds, Limited," which he presented at the last Annual Meeting of the Institute in London.

XUM

Magnesium Alloy Castings.

LECTURE ON RECENT DEVELOPMENTS AT COVENTRY.

The meeting of the Birmingham, Coventry and West Midlands Branch of the I.B.F. at Coventry, on Friday, November 8, served a dual purpose and attracted a gratifying response. In the afternoon a visit was paid to the new foundry of Morris Motors, Limited, at Courthouse Green Works, and in the evening a lecture with illustrations was given by Mr. E. Player (of Sterling Metals, Limited, Coventry) at the King's Head Assembly Hall on "Magnesium Alloy Castings." A company of nearly 120 went over the foundry, the tour lasting two and a-half hours and being conveniently conducted in small sections. Members from all over the country joined the party, which was received by Mr. A. Smith (in charge of the foundry) on behalf of Morris Motors, Limited. The size of the premises, their equipment and methods, proved to be a revelation to many. As Mr. Andrew Harley remarked later on, "We have seen something at a foundry dealing with cast iron which is rather amazing to most of us."

The Paper given by Mr. Player was read to a Birmingham gathering on December 13 last, and has already appeared in THE FOUNDRY TRADE JOURNAL.* One or two points, however, may be given in relation to the application of Elektron castings, of which magnesium is the base.

Elektron Castings for Moving Parts.

The lecturer said that a study of the mass-strength ratios would at once indicate that Elektron could be employed with advantage in many engineering structures. As regards power losses in moving parts, if the weight of such parts could be substantially reduced without sacrifice of the required strength and rigidity, it was apparent that there would be a reduction in the power consumption of the machine, due to the lowering of the inertia losses and reduced friction losses. This was more particularly the case with parts having intermittent or reciprocating motion. In the design and construction of mechanically-propelled road vehicles and aircraft, the necessity for a high power-weight ratio had always been recognised, with the result that aluminium alloys played a large part in their construction. In the field of general engineering, however, the point had not received the attention it deserved. There were doubtless many types of machines where light alloys such as Elektron could be used with considerable advantage, resulting as it would in lower running and maintenance costs and higher working speeds. If a substantial reduction was made in the weight of one component, it was obvious that the weight of those parts connected with it could be safely reduced by employing a smaller section (and weight) than hitherto, as the total power required to be transmitted was lowered by the saving of inertia and frictional losses in the light metal part, although the useful power transmitted remained the same. Thus, if Elektron castings were used instead of iron castings for the moving parts of a machine, it was possible to reduce the weights of those parts by at least 66 per cent. without sacrifice of strength, and a further reduction made might be due to the lower power now required to overcome inertia and frictional losses, particularly in reciprocating or intermittently moving parts. These considerations, plus the exceptionally good machining qualities of the metal, had already led to the wide adoption of these alloys for a variety of engineering purposes. Mr. Player proceeded to quote figures of weight reduction in respect to crankcases, gearboxes, road wheels and back-axle casings, of which illustrations were given, and also referred to aircraft castings and landing wheels, pistons for high-speed compressors and wheels for textile machinery. He pointed out that the reduction of unsprung weight in heavy motor vehicles tended to quicken acceleration and more effective braking, with longer tyre life and smoother travel. The substitution of Elektron for heavier metals in the construction of high-grade cars had appreciably reduced the deadweight, giving the effect of enhanced engine output without increased running costs. Forms of moulding rubber tyres had a considerable weight advantage over either cast iron or aluminium, with the additional special qualities that Elektron was entirely unaffected by sulphur during the moulding process, and machined up with a very smooth non-porous surface free from blow-holes or pin-holes. It was not suggested that finality had been reached, but there had been laid a solid foundation upon which future developments could be safely built.

* See issue of December 27, 1928, page 473.

Vote of Thanks.

Proposing a vote of thanks to the lecturer, Mr. Andrew Harley noticed the very fair manner in which Mr. Player had weighed up the relative qualities of different light alloys. He had not, for instance, claimed magnesium as superior to every other alloy, but had detailed the difficulties to be overcome as well as the advantages of that metal. One feature which impressed him was that magnesium-alloy castings were not put forward as being any stronger than aluminium castings, although they were lighter. Apparently they were being used for a wider variety of purposes than aluminium castings, and this fact seemed to him to afford encouragement to light alloy foundries in striking out in wider directions. Take road wheels, for example, which the lecturer had shown on the screen as the product of magnesium alloy, and which were lighter though not stronger than other types of wheels. Yet he believed that only one or two aluminium foundries had broken into this particular class of work. An important point in these magnesium castings was that they were free from blow-holes and pin-holes. Here lay a great advantage, and in this connection the aluminium foundries might learn a lesson on the difficult problem of melting and handling molten metal alloys from the methods adopted in regard to magnesium, in which he gathered that many precautions were taken as to pouring and the use of fluxes. Incidentally, he wondered whether the absence of blow-holes and pin-holes was due to these precautions. If so, aluminium foundries might take similar care and get clear of this bugbear of their calling. It had also occurred to him whether the sulphur dioxide atmosphere had anything to do with this freedom from blow-holes and pin-holes, because, if it had, then a new light was thrown on their cause. Concluding, Mr. Harley said Coventry was proud of Mr. Player and of his firm for the prominent part it had taken in the development of magnesium in foundry work. He himself was really lost in admiration at the perseverance and determination by which Mr. Player had overcome very great difficulties in developing this new line of metallurgy. With such material as that which had enabled Mr. Player's firm to attain this success, they ought to be able to boast of a very live section of the Institute in Coventry. Moreover, he ventured to say that in no area of similar towns were there foundries to be seen which were more advanced, not only as regards magnesium, but other metals as well. Surely they could now begin to expect closer interest among themselves in the scientific side of foundry work, and he would sincerely suggest that the best way of doing this was through the Institute. It had been a wonderful lecture.

Mr. Hurren seconded the vote, and Mr. Player, in reply, pointed out that it was only fair to say that a good deal of the progress made by magnesium alloys, after the technique was satisfactorily developed, had been built up on the work done in the aluminium founding industry. They had their path marked out once they had their technique in magnesium alloys put right. The two alloys, though not running on quite parallel lines, were near enough to be mutually helpful. In this connection Mr. Player declared that there was no danger of magnesium ousting aluminium. Metals were seldom mutually destructive, and generally were more helpful. In fact, there was an increasing scope for distinctive metals, all of which were being used more than ever before. As regards pin-holes, despite excellent work done, they were still a little bit in the dark as to the why and how. His own opinion, and he was far from being dogmatic on the point, was that freedom from pin-holes in magnesium-alloy castings arose from two causes: (1) The flux used was very highly solvent, not only in respect to oxides and compounds of that nature, but also, he thought, to gases, and (2) what was possibly the more likely solution—although it could not be confirmed without difficult and careful analysis, which he was not competent to undertake—that, contrary to aluminium, any gases occluded or dissolved in magnesium might quite possibly be retained in solid solution after freezing. This was not the case with aluminium and its surplus gases, as during the freezing stage it ejected a considerable proportion of them.

Discussion.

Mr. F. J. Cook raised a point as to the application of magnesium alloy to high-speed engineering work, remarking that one of the difficulties of the engineer was the weight of the moving parts. He was thinking particularly of Diesel engines. A great deal of progress had been made in reducing the weights of these parts, and he wondered whether this metal would be suitable for the pistons of Diesel engines having regard to the high temperatures involved and the searching nature of the gases. If that metal could be used successfully, then he thought there was quite a good field for it in that class of work, especially for high-speed Diesel engines. Was there any tendency towards crystallisation to cause weakness from shock?

Mr. Player stated, in reply, that a certain number of pistons was in use on the Continent made of electron, and produced from forged alloy, not cast. He understood they had met with a fair amount of success, but he could not say more. There was very great difficulty in obtaining even from high-grade aluminium alloy pistons to withstand the very high temperatures and severe stresses in Diesel engines. No magnesium alloy at present developed was so good as "Y" alloy for retaining its strength and hardness at elevated temperatures. However, magnesium alloy was being used to some degree for pistons in Diesel engines, and these were working fairly satisfactorily. He would point out that the conditions of working the engine must be thoroughly well known before pistons of suitable design could be produced to withstand the heavy duties imposed on them. Apart from the heat effect on the crown, it would be necessary to have a large area for the gudgeon-pin bearings, as forged-electron alloys were rather softer than hard-cast alloys. Replying to an interpolated question as to the composition of the gases being very aggressive, Mr. Player said this would not affect the metal. As regards shock, cast-magnesium alloy might be taken as being rather better than L5, assuming the casting was sound. There was not the same tendency to break short as there was with ordinary L5, and it was notably better than another well-known alloy—2L11. If Mr. Cook had in mind connecting rods for Diesel

engines, he might say that much water had to flow under the bridge before magnesium alloy was suitably produced for this purpose; they had not yet used Duralumin for connecting rods for those engines, and certainly not Elektron rods.

Replying to Mr. Westwood as to the effect of sea-water on magnesium alloys, Mr. Player said these alloys were susceptible to corrosion by saline solutions more than was the case with aluminium alloys, but a considerable advance had been made by alloying and surface treatment. In Italy, Elektron alloys were used for sea-planes, motor-boat work and even for propellers, and they claimed that it was satisfactory. Magnesium alloy was resistant to casual sea-water contact, but those engaged in its manufacture set their faces against its use for continuous or partially continuous contact. When properly produced it was not badly corrosive, but it was not suitable for constant immersion in sea-water.

Mr. Morgan Williams, speaking on the same point, mentioned that aluminium alloys varied considerably in resistance to corrosion. Copper-aluminium alloy was bad, but a silicon alloy modified was rather extensively used for component parts of outboard engines.

Mr. Player replied that it was generally recognised that aluminium-silicon alloys, where corrosion was the chief factor to be encountered, were superior to most other aluminium alloys and to magnesium alloys.

At the lecture Mr. E. H. Tyson (President of the Branch) took the chair, and, in welcoming members of the Coventry sections of the Institute of Automobile Engineers and of the Institute of Production Engineers, said that by arranging such meetings at Coventry they hoped to create fresh interest in the work of the I.B.F. Their organisation performed a work which was not only beneficial to the moulder, the foundry foreman and manager but also to the employer, and he might stress the fact that it was largely by the exchange of ideas that the foundry industry had progressed so much of recent years.

Mr. F. H. Hurren was then called upon to interpolate a few words, and reminded the meeting that at the annual conference of the Institute last June Mr. Andrew Harley was elected a Junior Vice-President, which meant that in June of 1931 he would become the President of the Institute. This was a great honour not only to Mr. Harley personally but to the Branch and to Coventry in particular. It was customary to hold the annual conference of the Institute at the headquarters of the Branch of which the President was a member, hence the 1931 conference would be held at Birmingham, and some of them thought it would be fitting that, under the circumstances, Coventry should take a definite part in the conference proceedings. Therefore they hoped to be able to arrange for one complete day to be allotted to Coventry (hear, hear), and a committee meeting would shortly be held in Coventry to start on the preliminary work.

The Imperial Steel Works, Yawata, Japan, have placed a contract with the Paterson Engineering Company, Limited, London, for a gravity sand-filtration plant. The capacity is 40 cub. metres of water per min. (12,662,000 galls. per day), and the plant is to be arranged for extension at a later date to 60 cub. metres per min. (19,000,000 galls. per day). The contract has been secured in the face of severe Continental competition, and after detailed investigation by Japanese Government officials of the various makes of filtration plant in operation. Apparently the water supply to the blast-furnace and general steel plant at Yawata is of a particularly difficult character as regards suspended material, and this is an unusual and interesting example of the utilisation of large modern rapid-gravity filters, such as are generally used for towns' water supply, in the iron and steel industries. Full details are not yet available, but a battery of standard "Paterson" rapid-gravity filters is to be installed, constructed of reinforced concrete on the "Hennebique" system.

London Foundrymen visit Kryn & Lahy's Steel Foundry.

Last Thursday the members of the London Section of the Institute of British Foundrymen visited the steel foundry of Messrs. Kryn & Lahy, of Letchworth. The guests were received by Mr. J. Deschamps, managing director, and Messrs. Shanks and Jack (foundry managers). The parties first passed through the machine shops, where a specially-designed machine for machining locomotive-wheel centres was the subject of favourable comment by the visitors. The machine, built by Craven Brothers, completely machines the casting in 35 minutes. A recent development of this works is the manufacture of the Campbell gas engine. A unique feature of the Kryn & Lahy organisation is that it manufactures its own oxygen requirements, by the liquefaction of air and fractional distillation. The fact that 60 to 70 per cent. steel scrap is used in the cupolas worked in connection with the converter plant, and that the majority of this requires preparation by the oxy-acetylene flame, coupled with the work of cutting-off runners and risers, accounts for the use of some 90,000 cub. ft. per week. The foundry has previously been described in our columns, whilst the installation of the Poumay system to the cupola plant has also been dealt with. Since this time, however, there has been a continuous mechanisation of the foundry. The sand slinger is now in successful operation, whilst the most recent installation is a Zimmermann F-type moulding machine. In this connection, we noted an interesting development designed to eliminate the necessity for box-pins. For certain work of not too deep a character, provision was made on the pattern plate for inserting on the face of the mould one concave and one convex hemispherical drop forging on opposite sides. The second half-mould is similarly dealt with, but conversely. In this manner an excellent fit is guaranteed initially and cross joints, due to the wear of box-pins and holes, are eliminated. The arrangement for heating up the ladles was shown to be particularly effective. Bottom pouring being general throughout the foundry, the stoppers are fixed in position, withdrawn to open the nozzle and inverted over one of a battery of 18-in. cylindrical castings filled with coke. The battery is connected to a small electrically-operated fan. The whole of the metal leaving the cupola is subjected to a soda-wash desulphurising process in a Neutraline-lined ladle. Alloy additions to the ladle are wetted so as to cause a slight explosion, with the object of ensuring that they pass directly into the metal and not merely rest and act upon the slag.

Afternoon tea was offered by the firm; Mr. Deschamps, who presided, was thanked by Mr. J. W. Gardom, the Branch-President, for the invariable courtesy shown by the management of Kryn & Lahy to the Institute of British Foundrymen. He congratulated the firm on their ability to keep their establishment working at full pressure, on their enterprise and exceptionally intelligent management. Mr. Deschamps, in reply, regretted that time had not permitted of a complete inspection of the plant, but hoped that the portions inspected had been interesting and educative.

Another stage in the progress of railway electrification in India has been completed by the official opening, on November 5, of the main line of the Great Indian Peninsula Railway from Kalyan to Poona. The contract for the overhead equipment for this work was placed with British Insulated Cables, Limited, of Prescot, and was followed by the placing of further orders with the same company for the overhead equipment of the line from Tnana to Kalyan. Work is in progress on the Kalyan-Igatpuri section of the main line. The total cost of the electrification scheme is in the neighbourhood of £8,000,000.

Book Review.

Edelguss-Eine Sammlung Einschlägiger Arbeiten, edited by Dipl.-Ing. G. Meyersberg. Published by Verlag von Julius Springer, Linkstrasse 23-24, Berlin, W.9. Price 11 mks.

This is one of the most interesting books ever presented to the foundry industry, as it is a collection of Papers dealing with high-strength cast iron. Apparently it is the second edition of Perlitguss, and since Perlit has now commercially joined forces with Emmel iron, this edition has been enlarged to include the latter. The book is sponsored by the "Edelguss Verband," which works on similar lines to the British Perlit Licensees' Association.

The book is divided into three main sections. After what amounts to a story of the chronological development of high-strength cast iron, from Diefenthaler's invention to the present time, which has been presented as a preface, the editor has chosen three Papers for his first section. These are by Dr. Jungbluth, Dr. Maurer (on the iron-carbon diagram) and Dr. Klingenstein on high-strength iron in general.

The second chapter opens with a section devoted to the improvement of cast iron by the production of a pearlitic matrix. Here there are contributions by Karl Sipp, Prof. Bauer, A. E. MacRae Smith (translated from The Foundry Trade Journal), Buffet and Roeder, the Editor and the firm of Steinmüller.

This is followed by two Papers from the pens of Dr. Kleiber (Krupp's Sternguss or Star iron) and Karl Emmel. They are classified under the heading of "Improvement through Carbon Control." The final section of this chapter is dealt with under the caption of "Improvement through Refining the Graphite," the contributors being Dr. Piwowarsky, Dr. Hanemann, Emmel and three foundries.

The third section can best be designated as related subjects, and its scope is indicated by a recital of the subjects and their authors. The first Paper is by Dr. Lehmann, who deals with the abrasion-resisting properties of cast iron. Then Sipp and Roll detail their experiments on Growth, including the influence of carbon silicon and manganese. After a small note by Dr. Jungbluth on the strength of high-test irons at elevated temperatures, and slightly longer ones on soundness of grey and Perlit iron under pressure tests by Roll, electric properties by Pinsl and classification of grey irons by Dr. Kühnel, there is an appendix detailing the patents granted for high-strength cast iron, both in Germany and elsewhere. A second appendix outlines a bibliography of the subject since 1922, and British founders can take pride in the very important position occupied by their research workers and this journal. The book has 129 pages and is excellently illustrated.

A New B.E.S.A. Specification.

The British Engineering Standards Association has recently published a standard specification for the hardness of steel balls for Brinell hardness testing, Part II of B.S. Specification No. 240. This specification forms the supplement to the report on Brinell hardness numbers which was issued in 1926, and in which a note was added indicating that the specification for the hardness of the balls would be prepared. The information embodied in the specification has been based upon the results of research which was carried out at the National Physical Laboratory. Recommendations as to the hardness of the balls to be used in testing materials of varying hardness is indicated, and tables are given from which the hardness of balls can be determined by means of the diamond, indentation test and reciprocal-pressure test.

Copies of this Specification can be obtained from the Publications Department of the British Engineering Standards Association, 28, Victoria Street, London, S.W.1, price 2s. 2d. post free.

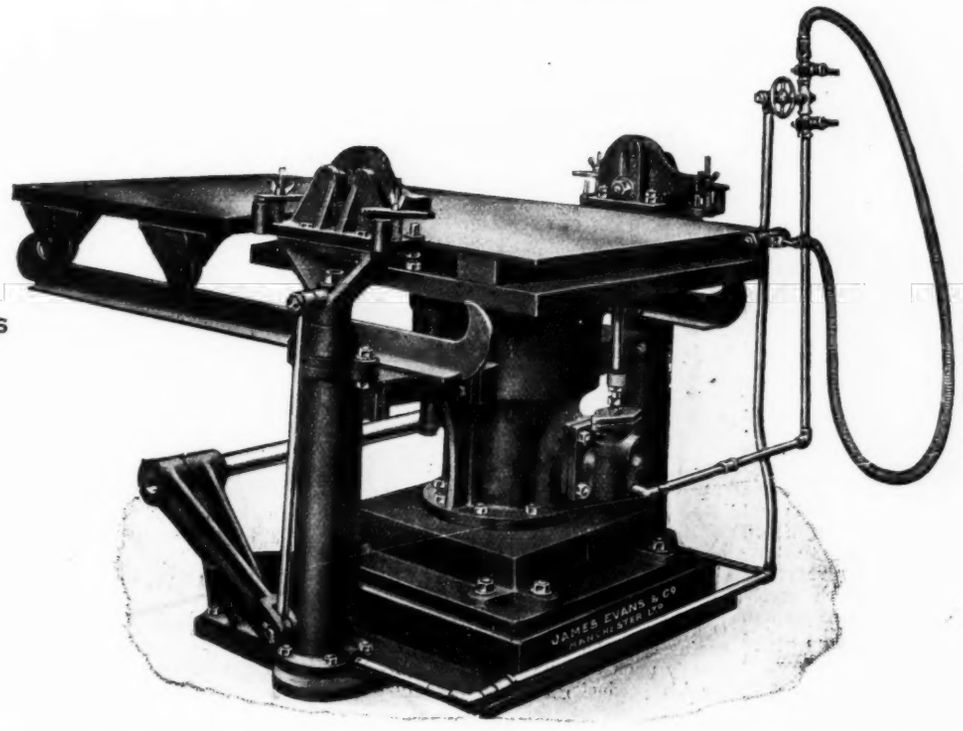
TYPE "C"

JAR RAM MOULDING MACHINE

with Turnover Pattern Plate.

For Pneumatic Power.

TWO MACHINES IN ONE.



UNSKILLED LABOUR ONLY REQUIRED.

The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

IT IS ALSO ENTIRELY OF BRITISH DESIGN AND MANUFACTURE.

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Imperial Foundry Group's International Sales Campaign.

At a time when charges of lack of initiative and energy on the part of British manufacturers receive so much prominence, it is most desirable that particulars of the very thorough and ambitious scheme of export marketing inaugurated by the Agricultural & General Engineers, Limited, should be widely known. It has been brought to a head by a letter addressed by its chairman (Mr. G. E. Rowland) to the Rt. Hon. J. H. Thomas, Lord Privy Seal, which is reproduced hereunder.

Sir,—In discussing the problems of unemployment you have frequently and rightly emphasised the importance of developing British exports, of an expansion of trade between the different parts of the British Empire, and of a consolidation of the selling organisations behind British goods in the various export markets of the world.

It is, therefore, with great pleasure that I am in a position to inform you of the completion of a comprehensive scheme of world marketing for agricultural engineering products. This scheme will cover the manufactures of the engineering group of which I am chairman, those of another important British firm, and those of the greatest Australian engineering concern, thus representing an important forward step in consolidating the manufacturing resources of the Empire in a combined offensive on the world market for agricultural machinery.

Agricultural & General Engineers, Limited, which already employs over ten thousand men, has agreed with the Rushton Tractor Company, Limited, of Walthamstow, and with H. V. McKay Proprietary, Limited, of Sunshine, Melbourne, Australia, to handle, in addition to its own products, the sales of the Rushton Tractors in all the principal world markets and of Sunshine Harvesting Machinery in South America.

This scheme is the culmination of five years' preliminary development, during which period branches have been established in the Argentine, Chile, South Africa, India and Australia, whilst a branch in New Zealand will be opened in January.

In each of these countries an intensive study has been made by expert technical engineers and designers to ascertain the special requirements and to test in the field the special types of machine required. In each of the main markets of the world our directors and chief sales representatives, to the number of thirty-nine, have carefully investigated the market conditions and sales requirements. At the same time, the Rushton Tractor Company have demonstrated by practical tests, both at home and abroad, the suitability of their tractor for a wide range of countries and conditions; while the McKay Proprietary, Limited, in conjunction with the A.G.E.'s South American representatives, have tested their harvesting machinery in the Argentine and proved its suitability for South American conditions.

The time has now come when our arrangements can be completed, and for the first time a combined effort made to place British and Empire manufactured agricultural machinery on a large scale in the markets of the world. The resources of the firms concerned are adequate to deal with the anticipated increase in turnover and employment, and any further financial support that may be required is available.

Dissection of the world's exports of agricultural machinery shows that almost 75 per cent. of the world's trade in these products is in tractors and harvesters. Our inability previously to supply the complete range of machines required by overseas farmers has been the main reason why the trade in these products has been to so large an extent controlled by our foreign competitors. The present scheme removes this handicap, and for the first time places us in a favourable position to obtain an adequate share for Great Britain of this very important trade. The agreement will also largely avoid the waste of time, money and effort occasioned by the single-handed competition of British firms against foreign competitors, who have combined in a single unit to supply the complete range of articles required.

Our export organisation is not only in a position to "deliver the goods," but to give service comparable with that of any foreign competing group. Indeed, we feel that it is sufficiently representative and elastic to handle not only the products covered by the existing agreements, but to deal with the products of other British firms in markets where such firms are not at present fully or adequately represented. We feel that the savings which could thus be effected would enable the industry not only to meet successfully the keen competition which now exists, but to obtain an increased share of trade for this country and the Empire. We are, therefore, prepared to consider favourably on broad and equitable principles any applications with this object in view.

In conclusion, I wish to acknowledge with gratitude the great encouragement and support that my group has received, not only during their preliminary efforts of the past five years, but in the completion of the present scheme, from their bankers, Messrs. Barclays Limited, from the Export Credits Department, from the Department of Overseas Trade, and from the Federation of British Industries.—Yours, etc.,

G. E. Rowland.
(Chairman of A.G.E., Limited.)

Rt. Hon. J. H. Thomas, M.P.,
Lord Privy Seal.

Problem Before the Industry.

As a result of over a century's application, research and attention to the special requirements of the British farmer, the agricultural engineer in the United Kingdom has been able to rely upon a major share of the home demand for his products, while, as the pioneer of the mechanisation of agriculture, he was able before the war to obtain a satisfactory share of the world demand.

The position has been greatly altered in the post-war period. His temporary absence from the international market during the war years left the field open to his foreign competitors, who secured a very great share of the huge volume of new business which arose from the increasing demands for machinery. In addition, at home, and especially during the last seven or eight years, he has had to face a greatly depressed market as a result of the continued depression in agriculture and the consequent restricted purchasing power of the British farmer. The result has been that the industry is classed as one of depressed trades.

The disability under which the British industry has laboured is that it has not hitherto been in a position to supply the complete range of machines required by the overseas farmer. For example, 75 per cent. of the world's total exports of agricultural machinery are in tractors and harvesters, two lines which the British agricultural engineer has only very recently begun to manufacture. It is, in fact, because the trade in these two main exports is largely controlled by overseas producers that the total exports of British agricultural machinery have up to the present been so small.

United Kingdom's Low Share of World Trade.

The present marketing scheme represents in one sense a determined effort to obtain for Great Britain a share of this great trade in tractors and harvesters, amounting approximately to over £20 million per annum. Apart from the United States, the world trade in agricultural machinery amounts at a rough estimate to between £25 and £30 million annually. Of this total, Great Britain's share stands at the low figure of approximately £2 million, or only 7 to 8 per cent. of the world's total. The present scheme should enable this position to be considerably improved.

Participants in the Scheme.

The firms concerned in this plan already employ over 12,000 hands, and represent a capital of over £4 million. During the last five years the A.G.E. firms concerned have with great thoroughness and energy, and at considerable cost (over £250,000 has already been spent in developing this scheme), sent directors and leading sales representatives, trained experts and demonstrators to visit all the world's markets for agricultural machinery, and have in addition opened their own establishments in:—Argentine, at Buenos Aires (Mr. Cullington); Chile, at Temuco (Mr. Caistor); South Africa, at Johannesburg (Major Guy Fetherston, D.S.O., late H.M. Trade Commissioner); India, at Calcutta (Sir C. E. Low, K.C.I.E.); and Australia, at Sydney (Mr. A. Simpson, late H.M. Trade Commissioner), and are in January establishing a branch in New Zealand.

In each of these markets expert engineers and designers have been studying special requirements, and directors and special sales representatives of the group, to the number of 39, have been, or 25 are at the moment, visiting every market where agricultural machinery is used. The participants in the scheme can, in fact, supply to any markets in the world all the machines and implements that the farmer requires, not only agricultural machinery alone, but all other types of article, ranging from a split pin to a bridge.

£8,000,000 of Business in Argentine.

The group of 12 firms constituting the British combination of agricultural and general engineers have an aggregate trading existence of over 1,200 years—three firms have each been manufacturing for over 150 years.

On the other hand, the Rushton Tractor Company, Limited, of Walthamstow, only placed their entirely British-manufactured tractor on the market last April, and this has already demonstrated in trials both at home and abroad that it can compete with any machine in the world for efficiency and economy. H. V. McKay Proprietary, Limited, of Sunshine, Melbourne, have built up a large trade for their harvesting machinery, and, as a result of joint demonstrations with the South American house of the A.G.E. in the Argentine, are convinced that a satisfactory share of the business in this market can be secured. The Argentine imports some £8,000,000 worth of agricultural machinery. By the agreement, the A.G.E. will handle the Rushton tractor in all markets of the world and the Sunshine harvesters in the South American market. Moreover, the A.G.E. contemplate manufacturing shortly in Great Britain harvesting machinery for other of the world's markets.

The resources of the firms concerned are fully adequate to deal with the increased turnover and employment anticipated as a result of this determined effort to increase export trade. Any further finance that may be required is available.

The selling organisation which has been built up during the last five years is sufficiently elastic to handle the products of other British firms in markets where they may not be represented, and, indeed, the participants in the scheme are prepared to consider such representation on broad and equitable principles so as to make the scheme a really concerned effort on behalf of the British manufacturer.

Solve dead-weight problems with a light alloy of

Aluminium Data Sheet A128

ALUMINIUM-COPPER-ZINC ALLOYS

F.T.J. 29.11.29

While a straightforward mixture of aluminium and zinc has good mechanical properties, is excellent for machining, and above all, is cheap, it is unfortunately 'hot short' or weak at high temperature. This causes difficulty in founding and in consequence simple aluminium zinc alloys are now rarely used.

The addition of a small percentage of copper greatly reduces the 'hot shortness' and has no adverse effect upon the mechanical properties or the machinability, and alloys of this nature are extremely popular for castings of all kinds.

The standard British alloy of this composition is that known as 2 L 5, which contains 12·5% to 14·5% zinc, 2·5% to 3% copper, and the remainder aluminium. This alloy is very extensively employed in Great Britain for gear-boxes, crankcases and even for parts subjected to high stress. Zinc-bearing alloys do not maintain their strength at high temperatures and should not therefore be used for pistons and similar parts.

The properties specified for a chill cast test bar in 2 L 5 alloy are 11 tons per sq. in. tensile strength and 3% elongation. These are minimum figures, but the average of a large number of tests shows that the following results may be expected :

	Sp. Gr.	Elastic Limit Tons/sq. in.	Ultimate Strength Tons/sq. in.	% Elong. in 2".	Brinell Hardness	Izod. Ft. lbs.
Chill Cast	2·99	6-8	11-16	3-10	65-70	5-7
Sand Cast	2·99	4·5-6	9-12	2- 4	62-65	2-4

Where high ductility is particularly desirable, this may be attained with the sacrifice of a certain amount of tensile strength by reducing the zinc content to, say, 8%, maintaining the copper content at 3%. Such an alloy, in the chill cast form, may have a tensile strength of 9 to 10 tons/sq. in. with a percentage elongation of 10% to 13% on 2 in.

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Trade Talk.

THE FOUNDRY plant at Wellhouse Mill Foundry, Barnolswick, was sold by auction on November 25.

MESSRS. ERITH'S ENGINEERING COMPANY, LIMITED, have removed from 83, Kingsway, W.C.2, to 33, Farringdon Street, London, E.C.4.

IT IS REPORTED that the Compagnie Générale Transatlantique has placed an order with a well-known Belfast firm for six cargo ships, each of 8,000 tons.

THE MIDLAND SAND BLAST & FOUNDRY SUPPLIES COMPANY, LIMITED, Castle Lane, Warwick, announce that their address after November 30 next will be 150, Holborn, London, E.C.1.

FIRE BROKE OUT recently at the premises of Messrs. Henry Barrett & Sons, Union Foundry, Cutler Heights, Bradford. The outbreak occurred in the control box of an electric crane.

ORDERS FOR foundry plant to the value of about £22,560 have been received since September 1 by the Universal System of Machine Moulding & Machinery Company, Limited, from customers in Great Britain.

"SOME LESSER KNOWN FACTS CONCERNING ALLOY STEELS" was the title of a Paper read before the last meeting of the Institution of Engineers and Shipbuilders in Scotland by Prof. J. H. Andrew, D.Sc.

THE CONTRACT for the erection of a new screening and conveying plant at the Bankfoot Coke Works of Messrs. Pease & Partners, Limited, has been placed with the New Conveyor Company, Limited, of Smethwick, Birmingham.

MESSRS. J. J. RUSSELL and A. E. Russell, carrying on business as ironfounders and iron merchants, at Oxford Foundry, Prospect Hill, Kidderminster, under the style of John Russell & Company, have dissolved partnership by mutual consent.

THE ARMSTRONG seadrome, a floating landing-field to aid transatlantic air navigation, will require about 15,000 tons of structural steel and plates, states the "Iron Age." About 9,000 tons of pig-iron or other suitable ballast material also will be used.

MESSRS. NAPIER & MILLER, LIMITED, Old Kilpatrick, have received an order from Cie de Navigation d'Orbigny, of Paris, for a second general cargo steamer. The ship will have triple-expansion reciprocating engines supplied by Messrs. John G. Kincaid & Company, Limited, Greenock.

MESSRS. BRUCE, PEEBLES & COMPANY, LIMITED, Edinburgh, have been granted by Messrs. Brown Boveri & Company, Limited, Baden, Switzerland, the sole manufacturing and also selling rights in Great Britain and Ireland of the mercury-arc rectifiers with which the name of the latter firm is associated.

IT IS STATED by the British Electrical and Allied Manufacturers' Association that calculations covering the first nine months of 1929 show an increase of about 50 per cent. in orders for electrical equipment secured from abroad by representative British firms. The heaviest orders have come from India and Australasia.

THE HARDY PATENT PICK COMPANY, LIMITED, Heeley, Sheffield, inform us that the report of the fire which occurred at their works on November 5 has been grossly exaggerated. It was stated that from 300 to 400 men would be thrown out of work, whereas only about 20 men were affected for a few days and have now started again. We understand that the firm's delivery of orders is unimpaired.

THE EMPLOYEES of the North British Locomotive Company, Limited, Queen's Park Works, Glasgow, have distributed the sum of £478 7s. amongst various hospitals and institutions, and those of Messrs. G. & J. Weir, Limited, Cathcart, Glasgow, have made a half-yearly payment of £404 from their infirmary fund to Glasgow and West of Scotland charitable institutions.

THE TRUSTEES for the holders of the 6 per cent. debenture stock of the Leeds Forge Company, Limited, have received an offer from Broadway Finance and Investment, Limited, London, acting in conjunction with the Metropolitan Cammell Carriage, Wagon & Finance Company, Limited, to purchase all of the stock at £80 per £100 of stock, plus interest calculated to December 31 next. The trustees recommend acceptance of the offer.

IT IS REPORTED in the "Iron Age" that the merger of four important American furnace interests—the Toledo Furnace Company, Toledo, Ohio; the Perry Furnace Company, Erie, Pa.; the By-Product Coke Corporation, Chicago, and the Zenith Furnace Company, Duluth—will form one of the largest merchant pig-iron producing companies in that country. The annual capacity of the combined companies will be about 1,100,000 tons, and the resources will amount to approximately $75,000,000.

THE CLYDE DISTRICT COMMITTEE of the Amalgamated Society of Woodworkers have agreed to the terms of settlement arranged by their executive and the Shipbuilding Employers' Federation. In accordance with this decision, instructions have been issued to the various branches advising a withdrawal of the ban on overtime and nightshift work, which has been in operation since February. Arrangements were made for the resumption of overtime and night work last Monday. More than 5,000 men were affected by this decision.

MESSRS. JOHN BROWN & COMPANY, LIMITED, Clydebank, recently launched the twin-screw geared turbine steamer "Prague," built for the London & North Eastern Railway for their Harwich-Hook service. The Ailsa Shipbuilding Company, Limited, Troon, have launched the steamer "Monarch," which was built to the order of Messrs. J. Hay & Sons, Limited, Glasgow. The new torpedo-boat destroyer "Acasta," built by Messrs. John Brown & Company, Limited, Clydebank, for the Admiralty, has carried out successful steering and reversing trials on the Clyde.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, Victoria Station House, Victoria Street, London, S.W.1, have recently received several important orders from abroad. They include a 3-ton open-hearth furnace-charging machine, with 5-ton auxiliary trolley, and an 85-ton ladle crane with 20-ton auxiliary trolley, for the Société Anonyme de la Fabrique de Fer de Charleroi; a 2¾-ton copper cathode furnace-charging machine, for the Société Anonyme Métallurgique de Hoboken; a 2½-ton combined stripping and charging machine, for the Société Anonyme des Forges et Aciéries du Nord et de l'Est, of Valenciennes, France; four ladle driers, for the Sociedad Anonima Altos Hornos de Viscaya, of Bilbao, Spain; two coke-quenching cars, for the Union Chimique Belge, of Brussels, for their Ostend works; and a set of electrically-operated coke-oven machinery, comprising combined coke-pushing, coal-levelling and door-extracting machine, coal-charging larry, coke guide and door-extractor machine, and coke-quenching car, for installation at the works of the Imperial Continental Gas Company at Pont Brule, Brussels, for the successors to the Otto Coke Oven Company, Limited.

Personal.

MR. J. R. WILLIS ALEXANDER has been appointed secretary of the Institution of Gas Engineers.

MR. JOHN HILL has been re-elected general secretary of the Boilermakers' Society for another term of three years.

SIR HUGH BELL has been re-elected chairman of the Tees Conservancy Commission for the twenty-sixth consecutive year.

SIR EDMUND WYLDBORE SMITH and Mr. Bernard D. F. Docker have resigned from the board of Associated Electrical Industries, Limited.

MR. SAMUEL SMITH, managing director of Messrs. Samuel Smith & Sons, Limited, ironfounders, Smethwick, has been elected Mayor of Smethwick.

MR. JAMES BRYDEN, works manager of Messrs. Smith & McLean, Limited, Glasgow, sailed from America for England on November 6, after a stay of several weeks in that country.

MR. WALTER GIBB GRAY, general manager, Steel Company of Scotland, Limited, has been returned unopposed as a member of Dumbartonshire County Council for the East Division, New Kilpatrick.

VISCOUNT EDNAM, chairman of the Earl of Dudley's Baggeridge Colliery, Limited, and the Earl of Dudley's Round Oak Works, Limited, has been nominated for the office of Sheriff of the county of Worcestershire.

MR. JAMES THOMPSON, one of the principals of the firm of Messrs. John Thompson Wolverhampton Boilers, Limited, Ettingshall, Wolverhampton, has been nominated for the office of Sheriff of the county of Staffordshire.

MR. JAMES KIRKWOOD SHANKS, J.P., managing director of Cruikshank & Company, Limited, Denny, has been re-elected Provost of the Burgh of Denny and Dunipace. He has also been re-elected as a member to the Stirling County Council.

MR. H. WARREN LEE, a special director of Messrs. Vickers-Armstrongs, Limited, and technical manager at Elswick Works, Newcastle, has been appointed technical adviser to the board of directors on naval armaments, and is leaving Elswick Works to take up his duties in London.

Wills.

HURLL, ALEXANDER, iron and steel merchant, Glasgow £71,626

JENNINGS, T. J., director of the Phœnix Engineering Company, Limited, Chard £8,387

GAMBLE, B., of Church Farm, Elkesley, Nottingham, and of Messrs. Moss & Gamble Bros., Limited, steel manufacturers, of Sheffield £20,423

MILLS, CHARLES ELLISON, Nunthorpe, chairman of Gjers, Mills & Company, Limited, ironfounders, of Ayresome Iron Works, Middlesbrough £73,627

PICKING, GEORGE GORDON, Bow, of Picking, Hopkins & Company, engineers, gun-metal and brass founders, of 58, Bow Road, London, E.3 ... £14,794

Obituary.

MR. FRED ROBINSON, works manager for Messrs. William Green & Company (Ecclesfield), Limited, engineers and ironfounders, has died at the age of 53 years.

THE DEATH occurred, at his residence in North Mount Vernon, near Glasgow, on November 16, of Mr. Robert Waddell, J.P. Mr. Waddell, who was in his 83rd year, was managing director and senior partner in the Acme Steel Foundry Company, Limited, Shettleston.

MR. MATTHEW SHIRKEY, a member of an old and well-known Carluke family, died at his residence in Wishaw on November 22. Mr. Shirkey was one of the few remaining men who worked at the old Castlehill Iron Works when these were in operation. Up to a few weeks ago Mr. Shirkey was in the employ of Messrs. R. Y. Pickering's Wagon Works, Wishaw, where he had been for forty years.

MR. CLARLES S. LE POER TRENCH, editor of the "American Metal Market" since 1899, died in St. John's Hospital, Brooklyn, U.S.A., on November 8, at the age of 75 years. He was born in England, at Stadbroke, and as a young man went to America. During the whole of his business career he was a prominent figure in the metal trade, and organised the firm of C. S. Trench & Company, non-ferrous metal dealers, of New York. Mr. Trench was chairman of the British Red Cross during the war, and later was active in the British Great War Veterans in America. He was also president of the British Empire Chamber of Commerce in America.

MR. GEORGE SCOBY-SMITH died at Linthorpe, Middlesbrough, last week, at the age of 85 years. For sixty years he was in the service of Messrs. Bolckow, Vaughan & Company, Limited, which he entered as a boy. He eventually became a director and commercial manager of the firm. He held important offices during the war. He was on the Provisional Advisory Council of the Board of Trade, a member of Lord Balfour's Committee on Trade, and after the war chairman of the committee appointed by the Board of Trade on the iron and steel trade. For his services he was created Commander of the British Empire. Mr. Smith was a director of the Steetley Lime Company, Limited, and the British Magnesite & Calcining Company, Limited. He was chairman of British Basic Slag, Limited, the British Railmakers' Association, the North-East Coast Plate and Angle Makers' Association, and of the Tees Wharfowners' Association. He was a Justice of the Peace for the North Riding of Yorkshire and the Borough of Middlesbrough. Mr. Scoby-Smith had travelled widely, and was well known in iron and steel circles in Germany, France, Belgium and the United States.

Applications for Trade Marks.

The following list of applications to register trade marks is taken from the "Trade Marks Journal":—

"U.H.B." surmounted by a crown.—Rolled or forged tubes of steel or iron. Uddeholms Aktiebolag, Uddeholm, Sweden.

"MAZAK."—Die-casting metal and metallic alloys. Morris Ashby, Limited, 17, Lawrence Pountney Lane, London, E.C.4.

"ANTICREUSIT."—Fusible metallic alloys. Jacques Gilbert, 54, Chatsworth Road, Brondesbury Park, London, N.W.2.

"SERVICE BCM/GX FIRST."

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SHEFFIELD 22311 (3 lines)
LONDON 1483 Central
GLASGOW South 1580
WORKSOP 205
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KELHAM ISLAND MILLS SHEFFIELD · LOWGROUNDS BRICKWORKS WORKSOP · *Notts.* · BULLBRIDGE BRICKWORKS AMBERGATE · *Derbys* · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · *Dur.* · BRACKENMOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · *Ayrshire*
AND AT MANSFIELD, WARSOP, EBBERSTON, CORBRIDGE, BRAMCOTE, LUFFENHAM, TOW LAW, MONTGREENAN &c.&c.

LONDON OFFICE
20 Budge Row E.C.4. (M° A.C. Turner)

Head Office
Wicker Arches, SHEFFIELD

GLASGOW OFFICE
82 Dale St. C.5 (M° A.W. Montgomery)

Something *really* new in
CUPOLA LININGS

After many years of careful study of technical literature and the advertisements of our contemporaries, we have been driven to the conclusion that there are

TWO WEAK FACTORS IN ORDINARY BRICK LININGS
(1) THE JOINTS (2) THE BRICKS

We have destroyed the first bogey for ever by the introduction of "PYROLYTE" Fire Cement which sets cold harder than the bricks, and makes joints that after weeks of severe use of the cupola stand out beyond the brickwork because of their greater strength and infusibility.

[Sample cwt. in free steel drum 30/- delivered]

For some time now, we have been trying to solve the second problem by the production of a

"PYROLYTE BRICK"

which will possess the remarkable virtues of the fire cement combined with those additional qualities needed in a brick—We *think* we have succeeded but—

WE NOW NEED THE HELP OF HALF-A-DOZEN FOUNDRYMEN WHO WILL TRY OUT A RING OR TWO OF THE SAMPLE BRICKS WE WILL MAKE TO THEIR SIZE AND DELIVER TO THEM FREE IF THEY WILL KINDLY WRITE US WITH PARTICULARS.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The position in the Cleveland iron market continues much the same as when previously reported, business still remaining in a state of uncertainty as regards the outcome of the present difficulties in the mining industry, and the probable effects of an early advance on fuel costs in relation to pig-iron prices now barely sufficient to cover expenditure on production. Unfortunately this controversy is apparently inevitable whenever a change of Government occurs, and until some definite solution of the problem is reached, if ever, markets for industrial products and material must continue unsettled. It must, however, also be recognised that the final months of the year are invariably a slack period of business in the pig-iron industry as regards buying on forward account, and for the present makers are quite content to maintain outputs at an average just sufficient to meet current requirements. One satisfactory phase of the trade situation is the complete cessation of imports of foreign iron for use in the local steelworks. Local needs are now being exclusively met by local blast furnaces. On the other hand, there is not much export demand for Cleveland iron, the price of which is too high to command much attention abroad. Prices, meantime, are unchanged as follow:—No. 1 Cleveland foundry iron, 75s. per ton; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge iron, 71s. per ton.

Makers of East Coast hematite, having mostly well-filled order-books, are now fairly well situated, and are now in a position to insist on a higher level of prices. Thus, for deliveries over the first three months of next year 80s. is now the minimum quotation, while in some cases 81s. is asked. As compared with these prices, some buyers are able to obtain prompt parcels at 78s. per ton, but the general quotation for mixed numbers is now 78s. 6d. On the North-West Coast, Bessemer mixed numbers are quoted at 77s. at works.

LANCASHIRE.—Although quiet, business in local markets for foundry pig remains fairly active for this period of the year, with Lancashire consumers on the whole taking fair quantities. Prices are quite firm, Midland brands being quoted at 77s. per ton for Derbyshire and Staffordshire No. 3, for delivery to local consumers. Scottish iron is only in quiet demand at from 92s. 6d. to 93s. 6d. per ton delivered.

THE MIDLANDS.—The demand for foundry pig throughout this area is fairly well maintained, and deliveries to consumers are in substantial tonnages. Quotations are firm as follow:—Minimum zone rates: 75s. for Northants No. 3, 78s. 6d. for Derbyshire No. 3 and 79s. 6d. for North Staffordshire No. 3, and Scotch brands 95s., all per ton delivered local stations.

SCOTLAND.—With few exceptions Scottish foundries continue only partially employed, and consequently demand for pig-iron is the reverse of active. Makers, however, maintain quotations firmly at 76s. per ton for No. 3 quality f.o.t. furnaces.

Finished Iron.

Black Country manufacturers of this class of material report only a quiet business passing, while there is no improvement in the demand for crown bars, the price of which, for good grades, is £10 5s. basis, delivered this area, although other crown qualities can be obtained at down to £10 per ton. None of the makers is able to keep his works going fully, and the conditions are far from entirely satisfactory. Still less business is possible for nut and bolt iron, as the makers of this grade have to bear the brunt of the foreign competition. Continental No. 3 bars are now being offered freely at £6 7s. 6d. delivered in this district, and somewhat under this would be possible for good orders. The only satisfactory feature so far as this district is concerned is the continued demand at appreciable rates for Staffordshire marked bars, which are quoted at £12 10s. at works.

Steel.

At Sheffield this week the outlook in the markets for steel and semi-products was not regarded as favourable to an early improvement, and business was on a somewhat restricted scale. Basic billets are quieter than for a long while, and the call for acid billets is small. Wire rod makers, too, are feeling the effects of sharper competition from the Continent. All prices are, however, maintained, and with production costs and selling prices so nearly at a level, there is little prospect of reduction. Quotations:—Basic billets, soft, £7; semi-hard, £7 12s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; Siemens acid, £9 10s.; wire rods, soft, £8 2s. 6d.; medium, £9 15s. to £10; hard, £10 10s. to £11; acid, £12 5s. to £12 10s.; steel hoops, £9 15s. to £10. The demand for finished steel is quiet, although the shipyards are taking good quantities of material from the British steelworks. New contracts, however, are scarce, but there are some prospects of business improving in this direction from the recent placing of shipbuilding orders on the North-East Coast. In the tinplate market prices are fairly well maintained, quotations ruling at 18s. 9d. to 18s. 10½d. for coke tins net cash, f.o.b. Welsh ports.

Scrap.

Reports from the various centres of trade in foundry scrap metal indicate few variations in the conditions of the markets, business continuing quiet as a general rule. On Tees-side the foundries are still taking small quantities of ordinary heavy cast iron at 66s., and machinery quality in convenient sizes commands a fair sale at 68s. 6d. In the Midlands there is still a fairly good demand for cast-iron scrap, 70s. being quoted for machinery cast iron in cupola sizes, 65s. for ordinary heavy metal, and 60s. for light cast-iron scrap. In Scotland many foundries are still short of orders, but notwithstanding prices are unchanged, with ordinary cast iron firm at 66s., and good machinery quality in handy sizes commanding 68s. 6d. Light cast-iron scrap is at 60s., with cast-iron firebars at 57s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Values in markets for base metals this week suggest a steady improvement in the outlook, and values show a distinct advance from the recent low levels. The discrepancy between the prices of standard and electro, however, has not so far led to the increased shipments of standard copper to the United States for refining purposes which might have been expected, and which would have been almost inevitable in circumstances of more equilibrium between supply and demand than probably exist to-day.

Closing quotations are :—

Cash.—Thursday, £69 17s. 6d. to £70 2s. 6d.; Friday, £71 12s. 6d. to £71 17s. 6d.; Monday, £71 15s. to £72 5s.; Tuesday, £71 5s. to £71 10s.; Wednesday, £69 to £69 2s. 6d.

Three Months.—Thursday, £69 7s. 6d. to £69 12s. 6d.; Friday, £70 15s. to £70 17s. 6d.; Monday, £70 17s. 6d. to £71; Tuesday, £70 5s. to £70 6s. 3d.; Wednesday, £68 to £68 2s. 6d.

Tin.—During the past week values of standard tin marked an advancing tendency, and at the close improved to the extent of £7 10s. per ton as compared with a week earlier, and of £13 10s. compared with the recent low level. This increasing confidence is attributable to improved trade buying and to freer purchases being made in the East by America. A further favourable factor has been the announcement that the council of the Tin Producers' Association is working on a plan for co-operation between mining and smelting interests.

Official closing prices :—

Cash.—Thursday, £184 to £184 5s.; Friday, £186 to £186 5s.; Monday, £190 2s. 6d. to £190 5s.; Tuesday, £188 10s. to £188 15s.; Wednesday, £184 15s. to £185.

Three Months.—Thursday, £186 10s. to £186 15s.; Friday, £188 10s. to £188 12s. 6d.; Monday, £192 7s. 6d. to £192 12s. 6d.; Tuesday, £191 5s. to £191 10s.; Wednesday, £187 15s. to £188.

Spelter.—Values of spelter continue fairly steady, though business is on a somewhat restricted scale. The Zinc Cartel, at their recent meeting in Brussels, decided not to renew the existing agreement, which was denounced as from December 31. A committee was instructed to draw up a new agreement for submission to a meeting of the Cartel to be held in the first fortnight of December. The outcome of the committee's deliberations will be awaited with interest.

Daily quotations are :—

Ordinary.—Thursday, £20 1s. 3d.; Friday, £20 2s. 6d.; Monday, £20 7s. 6d.; Tuesday, £20 5s.; Wednesday, £20 2s. 6d.

Lead.—The market for soft foreign pig remains steady, and it is not believed that the existing control will allow prices to decline much further.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £21; Friday, £21 10s.; Monday, £21 10s.; Tuesday, £21 10s.; Wednesday, £21 17s. 6d.

TEAM BY-PRODUCT COKE CO., LTD.
DUNSTON-on-TYNE
"TEAM" PATENT COKE
SPECIAL FOUNDRY QUALITY
FOR PRICE AND PARTICULARS APPLY TO:—
ALEXANDER LEITH & CO.,
25, COLLINGWOOD STREET,
NEWCASTLE-ON-TYNE.
TYPICAL ANALYSIS (if necessary guaranteed).
ASH not exceeding 8%
SULPHUR " " 0·8%
VOLATILE " " 1 %
MOISTURE under 1·50%

800 4-LB. CASTINGS IN 8½ HOURS

WITH
ONE MAN
ONE BOY
ONE MACHINE

AND **STERLING BOXES**

Making Repetition Castings for **"BENNIS" STOKERS** at the Works of Messrs. EDWARD BENNIS & CO., LTD., LITTLE HULTON, BOLTON

This man and boy make up 100 pairs of boxes each morning (4½ hours). In the afternoon they pour their own metal, shake out the boxes and stack ready for the next day's work.

The boxes are STERLING STYLE "KA" 16" ×26" ×3½" deep each part. Eight 4 lb. Castings are made in each box.

Total Number of Castings made per day by each machine -	**800**
Weight of actual castings produced - - - - - - -	**3,200 lbs.**
Percentage of Scrap - - - - - - - - -	**Practically Nil**

A creditable performance even with "STERLINGS" and a convincing proof of our claim that

STERLING BOXES SAVE LABOUR, INCREASE PRODUCTION, PRODUCE BETTER CASTINGS AND MAKE FOR ALL ROUND EFFICIENCY IN THE FOUNDRY.

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
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BEDFORD.

Telephone: 3345 BEDFORD.
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Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	69	0	0
Three months	68	0	0
Electrolytic	83	0	0
Tough	76	5	0
Best selected	76	15	0
Sheets	110	0	0
India	91	0	0
Wire bars	84	0	0
Do. Dec.	84	0	0
Do. Jan.	84	0	0
Ingot bars	84	0	0
H.C. wire rods	85	0	0
Off. av. cash, October	72	17	2 17/23
Do., 3 mths., October	73	4	1 4/23
Do., Sttlmnt., October	72	17	6
Do., Electro, October	84	5	2 1/23
Do., B.S., October	77	15	10
Do., wire bars, October	84	10	10 11/23
Aver.spot price,copper,Oct.	72	17	2 17/23
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¾d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	11½d.
Wire	10 7/8d.
Rolled metal	10¾d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	8½d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	184	15	0
Three months	187	15	0
English	185	10	0
Bars	191	15	0
Straits	192	10	0
Australian	191	0	0
Eastern	194	7	6
Banca	199	10	0
Off. av. cash, October	190	17	7 7/23
Do., 3 mths, October	194	17	3 9/23
Do., Sttlmt., October	190	17	7 7/23
Aver. spot, October	190	17	7 7/23

SPELTER.

	£	s.	d.
Ordinary	20	2	6
Remelted	19	0	0
Hard	17	10	0
Electro 99.9	22	10	0
English	20	12	6
India	18	10	0
Zinc dust (Nom.)	31	10	0
Zinc ashes	6	10	0
Off. aver., October	23	2	6 15/23
Aver., spot, October	22	18	6 9/23

LEAD.

	£	s.	d.
Soft foreign ppt.	21	7	6
English	22	15	0
Off. average, October	23	4	9 9/23
Average spot, October	23	4	6 3/23

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	29	10	0
Do. V.M. ex-whf.	28	10	0
Rods	33	0	0
Boiler plates	26	10	0
Battery plates	27	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	48	15	0
Chinese	31	10	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	19	0	0
Ferro-vanadium—			
35/50%	12/10 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	1/- lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	3/1½ lb.		
Tungsten metal powder—			
98/99%	3/3½ lb.		
Ferro-chrome—			
2/4% car.	£30	10	0
4/6% car.	£23	2	6
6/8% car.	£22	0	0
8/10% car.	£21	15	0
Ferro-chrome—			
Max. 2% car.	£33	5	0
Max. 1% car.	£39	0	0
Max. 0.70% car.	£41	0	0
70%, carbonless	1/- lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£12	10	0
76/80% packed	£13	10	0
76/80%, export	£13	0	0
Metallic manganese—			
94/96%, carbonless	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	0
Finished bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				3	10	0
Bundled steel and shrngs.	3	6	0 to	3	9	0
Mixed iron and steel	3	5	0 to	3	6	0
Heavy cast iron	3	0	0 to	3	1	0
Good machinery for foundries	3	2	6 to	3	5	0
Cleveland—						
Heavy steel				3	5	0
Steel turnings				2	17	6
Cast-iron borings				2	13	6
Heavy forge				3	15	0
W.I. piling scrap				3	10	0
Cast-iron scrap	3	4	0 to	3	7	0
Lancashire—						
Cast-iron scrap	3	2	6 to	3	10	0
Heavy wrought				4	0	0
Steel turnings				2	17	6
Scotland—						
Heavy steel				3	12	0
Cast-iron borings	2	13	6 to	2	15	0
Wrought-iron piling				3	18	0
Heavy machinery				3	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	63	0	0
Brass	43	0	0
Lead (less usual draft)	19	10	0
Tea lead	16	0	0
Zinc	14	0	0
New aluminium cuttings	66	0	0
Braziery copper	57	0	0
Gunmetal	57	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	79/-
Hematite M/Nos.	78/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry.*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	69/6
,, fdry. No. 3	73/6
Lincs. forge.	72/-
,, fdry No. 3	76/-
E.C. hematite	87/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	0	0 to	9	5	0
Hoops				11	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip				11	0	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	12	6 to	8	17	6
Boiler plts.	9	12	6 to	10	10	0
Chequer plts.				10	12	6
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and squares, 3 in. to 5½ in.				9	2	6
Rounds under 3 in. to ⅜ in. (Untested)				8	2	6

and upwards

Flats—8 in. wide and over				8	7	6
,, under 8 in. and over 5 in.				8	12	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs)				9	15	0
Black sheets, 24 g.				10	5	0
Galv.cor.shts., 24g.	12	15	0 to	13	2	6
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	6	5	0 to	6	15	0
Billets, hard	7	10	0 to	8	0	0
Sheet bars				6	5	0
Tin bars				6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.40
Plain wire	2.40
Barbed wire, galv.	3.05
Tinplates, 100-lb. box	$5.35

COKE (at ovens).

Welsh foundry	32/6 to 35/-
,, furnace	27/6 to 32/6
Durham and Northumberland—	
,, foundry	22/6
,, furnace	21/-
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/9
,,	28×20 ,,	38/-
,,	20×10 ,,	27/6
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	16/-
,,	28×20 ,,	34/-
,,	20×10 ,,	22/7½
,,	18¾×14 ,,	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0 to	£18	10	0	
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	15	0	
Blooms	£10	0	0 to	£12	0	0	
Keg steel	£32	0	0 to	£33	0	0	
Faggot steel	£20	0	0 to	£24	0	0	
Bars and rods dead soft, steel	£11	0	0 to	£14	0	0	

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas ..	65%	47½%
Water ..	61¼%	42½%
Steam ..	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	21 ..	69	17	6	inc.	7/6
,,	22 ..	71	12	6	,,	35/–
,,	25 ..	71	15	0	,,	2/6
,,	26 ..	71	5	0	dec.	10/–
,,	27 ..	69	0	0	,,	45/–

Electrolytic Copper.

		£	s.	d.		
Nov.	21 ..	81	10	0	No change	
,,	22 ..	82	15	0	inc.	25/–
,,	25 ..	83	0	0	,,	5/–
,,	26 ..	83	0	0	No change	
,,	27 ..	83	0	0	,,	,,

Standard Tin (cash).

		£	s.	d.		
Nov.	21 ..	184	0	0	inc.	87/6
,,	22 ..	186	0	0	,,	40/–
,,	25 ..	190	2	6	,,	82/6
,,	26 ..	188	10	0	dec.	32/6
,,	27 ..	184	15	0	,,	75/–

Tin (English ingots).

		£	s.	d.		
Nov.	21 ..	185	0	0	inc.	90/–
,,	22 ..	187	0	0	,,	40/–
,,	25 ..	191	5	0	,,	85/–
,,	26 ..	189	15	0	dec.	30/–
,,	27 ..	185	10	0	,,	85/–

Zinc Sheets (English).

		£	s.	d.		
Nov.	21 ..	29	10	0	dec.	20/–
,,	22 ..	29	10	0	No change	
,,	25 ..	29	10	0	,,	,,
,,	26 ..	29	10	0	,,	,,
,,	27 ..	29	10	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Nov.	21 ..	20	1	3	dec.	12/6
,,	22 ..	20	2	6	inc.	1/3
,,	25 ..	20	7	6	,,	5/–
,,	26 ..	20	5	0	dec.	2/6
,,	27 ..	20	2	6	,,	2/6

Lead (English).

		£	s.	d.		
Nov.	21 ..	22	10	0	dec.	5/–
,,	22 ..	22	15	0	inc.	5/–
,,	25 ..	22	15	0	No change	
,,	26 ..	22	15	0	,,	,,
,,	27 ..	22	15	0	,,	,,

AVERAGE MONTHLY PRICES OF IRON HOOPS.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 0
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 8
1898	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 6
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 9
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 8
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 2
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 0
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 6	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 2 0½
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 1½
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 2½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	11 13 6	11 15 0	11 12 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 14 10½
1929	11 10 0	11 10 0	11 10 0	11 10 0	11 9 0	11 5 0	11 5 0	11 5 0	11 5 0	11 2 0	—	—	—

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THE Proprietor of British Patent No. 190928, dated January 18, 1922, relating to "Improvements in Drop Hammers," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

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